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The destruction, rehabilitation and future development of the signalling on the Netherlands Railways,(*)

by J.H. VERSTEGEN,

Chief Signal Engineer, Netherlands Railways.

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PART I.

DESTRUCTION AND REHABILITATION.

September 1939.

At the Railway Exhibition at Amsterdam organised on the occasion of the Netherlands Railway Centenary, signalling was much in evidence and some remarkable examples of progress in it were to be seen. Thanks to developments carried out on these railways themselves the Netherlands signalling system could fairly be regarded by other countries as being among the best in Europe. It is also one of those few, which lays down its own signalling plans, independently of the factories, which allows the Dutch signalling industry to obtain its proper share in the work to be carried out.

The accident statistics are particularly good : *during the last three years no passenger has been killed in a train accident on the Netherlands Railways.*

It was explained to the 300 000 visitors to the exhibition that « in this way, each day and each night, over the tracks and over the points and crossings, in perfect safety, run in the service of the Netherlands people their splendid and well appointed express trains ».

In the meantime war between Germany and Poland broke out.

May 1940.

Eight months later, the invader fell on our country too. After a short, heroic and hopeless struggle the amount of destruction or damage sustained by the signalling equipment could be stated in round figures to be about 40 stations and signal boxes, or more than 6 %.

May 1945.

It was difficult for us to imagine how this damage, very serious though it was, would become as nothing in comparison with the chaos of destruction and looting, which we found facing us at the time of the liberation. The fine signalling installations once met with on the

(*) Paper read at Utrecht on the 27th June 1946, before the Royal Institution of Netherlands Engineers, Traffic Section.

Netherlands Railways had litterally disappeared.

Below we give, in its main features, a statement of what was destroyed and to what extent, after the lapse of about a year, rehabilitation had been effected.

May 1945-1946.

The signalling installations at some 80 stations and block posts were completely destroyed or very seriously damaged (among them 13 large stations); in addition 420 other installations had suffered less serious damage, or altogether 500 out of a total of 632, or about 80 % ; of this number 300 are at the present time (*) restored to working order and 100 partially so, so that on the lines *open to traffic* more than 80 % of the installations are once more fitted with the necessary safety devices.

The 2 000 km. (1 242 miles) of line fitted with block signalling, including automatic signalling, were *all* more or less damaged and in great part totally destroyed or taken away by the enemy. About 70 % are now again in service, amongst them some 50 % of the automatic signalling sections.

The same applies of the 50 automatic flash-light signals at level crossings; *not a single one* was functioning but now 50 % are again in working order.

Of the 825 km. (512 miles) of cables between locations only 200 km. (125 miles) were intact, so that some 75 % were out of use. At present 85 % are again in order and shortly the figure will be 100 %.

Fig. 1. — Where the Venlo-Nijmegen line used to run.

The telegraph and telephone open line wires were destroyed or made defective to the extent of 80 %. At the moment about 85 % have been restored.

Of the telephonic and telegraphic equipment, 80 % had disappeared; 95 % of the telephone apparatus is again in service (the telegraph system of lines will, for the most part, not be set up again).

Of the 19 automatic telephone exchanges, 11 had been destroyed or removed,

(*) Here and throughout this article *at the present time* means *the year 1946*.

and the remaining 8 were damaged or partially demolished. Of these 17 have been restored to working order.

Out of the 123 manual exchanges, 80 % were destroyed, removed or damaged; 90 % are again functioning.

All the radio-telephone installations were destroyed or stolen; 35 % have been put into service again.

The 26 Telex installations all disappeared; 75 % are now working again.

under-fed and exhausted staff, we were obliged to begin and make a first effort to get things into shape again. In the very first days the southern part of the country, liberated somewhat before, was able to render very appreciable help in spite of the scarcity which obtained there also. In this region the « Royal Signals » rendered very valuable aid towards the provisional re-establishment of the open line wires for telephone

Fig. 2. — The destroyed No. 1 signal box at Venlo.

Almost all tools and measuring instruments, the greater part of reserve equipment, and many of the important plans, disappeared.

Means adopted to remedy the situation.

It appeared a hopeless task to endeavour to bring order out of such chaos, especially seeing that the necessary tools and equipment and all means of communication were lacking. Hardly one member of the staff possessed a bicycle suited to the work, few had satisfactory footwear, while for effecting the first preliminary jobs, screwdrivers and other simple tools had to be borrowed from the homes of the staff. In a very primitive and difficult way, and with an

and other purposes. Whenever this could be done, we called them to our assistance and help was always given us within the limits of what was possible.

As soon as a few motor cars became available, things progressed more rapidly; it was possible to make inspections, convey staff and materials, establish communications with the south of the country, and so on.

A great improvement was effected by the putting into service of the first trains. These were known as « pilot » trains, running without any means of protection — even telephonic — and acting as a sort af breakdown train going to inspect the condition of the track and ascertain the condition of the

stations and signal boxes. These trains generally ran « on sight »; neither stations nor signal boxes could be advised of their running.

The next stage was represented by the so-called « repatriation trains » which travelled equally without any protection, partly still as breakdown trains, and partly, however, with the aid of telephonic messages, although very defective ones. The first of such trains ran from Amersfoort to Amsterdam and The Hague via Utrecht. (Passengers by these trains were conveyed by motor bus from Amersfoort to the Vlasakkers camp from which point the trains commenced their journey.) Shortly after, however, trains began to run to convey food for revictualling towns as well as passengers.

The number of telephone circuits was gradually extended as much as possible, in view of the fact that, although primitively arranged, such equipment provided a degree of security attainable more quickly than by any other means.

The number of trains was, however, so reduced that there was practically no chance of two trains being in a block section at the same time.

Fig. 3. — Interior of signal box T at Roermond after bombardment.

Stations.

At the great majority of the stations every item of signalling equipment was gone or in a defective conditions, and in those cases where it was intact it had to be inspected, tested and put in working order by means of the very primitive aids available before it was possible to rely upon it functioning properly. In those cases where the equipment was destroyed or seriously damaged the usual procedure was as follows : a home signal post was erected, or was declared to be effective as such, wherever possible preceded by a distant or caution signal post, or a warning approach board, and at this post every train was required to stop and be brought forward by a pilotman. The following stage was then usually the bolting of certain points and the working of the home signal, which dispensed with the obligation to stop at the latter.

Draw-ahead signal post.

In those instances where it was not possible to bolt the points in a given route for a sufficient distance to permit of the clearing of the home signal without causing inconvenience, a new arrangement was introduced known as the « draw-ahead » signal *(oprijseinpaal)* by means of which a « restricted safety » indication was given, in order to allow of a train being brought in, with the object of keeping the traffic moving, without having first to stop it at the home signal, to be installed in due course. This draw-ahead signal arm took the place of the home signal for the time being and like the latter was kept normally at danger *(red)*. In the « off » position, however, by means of a short square-ended arm inclined at 45 deg. in the lower quadrant it indicated « draw-ahead slowly » *(yellow)*.

The distant signal in rear, ordinarily acting for the home signal, was not worked but kept at « caution ».

As need required, the next stage consisted of introducing temporary safety measures on a more extended scale, followed by a proper installation. In certain large stations the fitting of the definitive equipment will still require a fairly long time.

Large stations.

Particulars of the position at certain large stations are as follows :

Eindhoven.

At *Einhoven* the signal boxes had been blown up. When the first temporary measures were taken a simple form of safe working was ensured by using a postal department van as a temporary signal box. Little remained of the automatic telephone exchange or other telephone equipment. Almost everything had been carried off. (Here, as elsewhere, the situation was met provisionally by establishing means of communication as much as possible with the aid of magneto-telephone apparatus.)

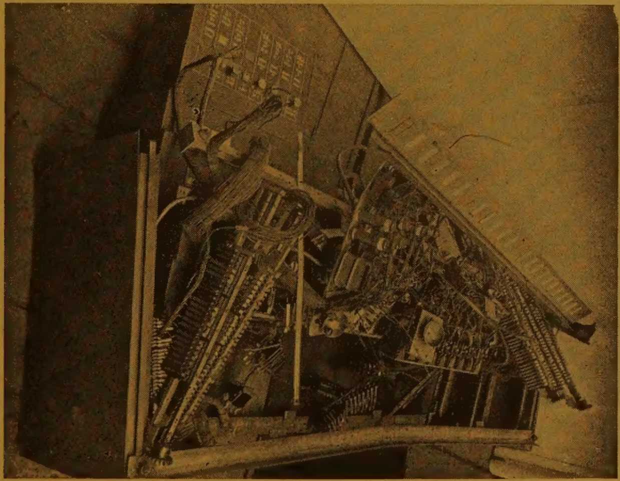


Fig. 4. — The electric power frame at Muiderpoort station (Amsterdam) as it was when sent back from Germany.

In view of the approaching complete re-arrangement of Eindhoven Station, it is being considered sufficient to rebuild as a temporary safety measure and on a reduced scale the old installation, largely with the aid of apparatus being constructed in the country and an electric power frame for signal box T, of Swedish origin.

Old equipment supplied from Sweden.

Following alterations made to the signalling installations in Sweden, some second-hand apparatus belonging to the State Railways there became available, and we were able to acquire this. These old Ericsson type appliances are in fact substantially the same as the single row type of frame made by the V.E.S. (Siemens) of Berlin, formerly our principal supplier of electric power frames but now totally eliminated as far as we are concerned.

As our old 7 row and 5 row frames were provided exclusively by the V.E.S., we have been obliged completely to change our course in this matter.

We therefore addressed ourselves to certain foreign firms and shall return to the matter later in this article.

Roermond.

Here again different temporary measures have been taken to obtain safe working; the A and B signal boxes are to be re-established with the aid of the Swedish type equipment mentioned above.

Arnhem.

Here everything was practically totally destroyed, chiefly by fire. The signals and points also suffered a lot of damage, as well as the wire transmissions, by tanks being driven over the station ground.

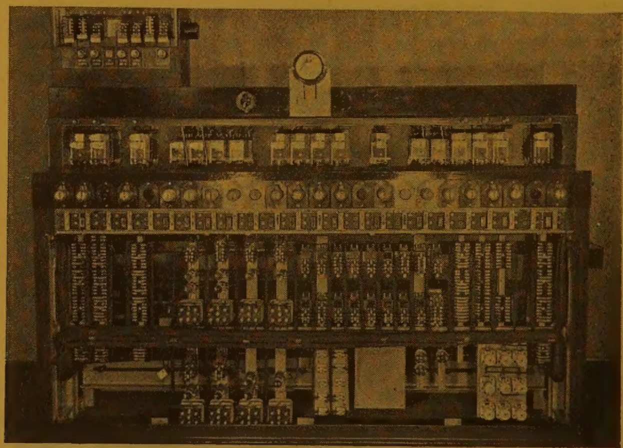


Fig. 5. — The same frame after being repaired in the Netherlands Railways workshops.

Temporary measures were taken at once to get some degree of safety, but by means of equipment made in the country, and the position existing prior to the strike was able to be approximately re-established.

The installing of the final arrangements depends on the proposals in view for dealing with Arnhem.

Bois-le-Duc (Hertogenbosch).

All the signal boxes at this place were destroyed.

A temporary signalling installation has been built, the extension of which is effected at the same time as associated lines of way are brought into use.

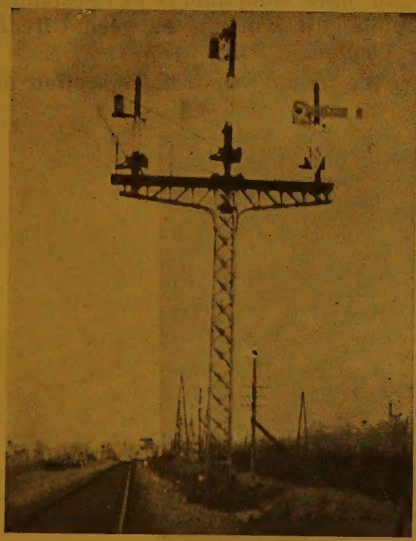


Fig. 6. — Drawahead signal leading to platform section at Apeldoorn, arm at danger.

For the final arrangement, discussions are being held with America on the subject of the so-called « N-X electric interlocking », to which reference will be made later.

A similar situation was met with at *Venlo, Boxtel, Lage Zwaluwe, Zwolle, Gouda, Heerlen, Amersfoort, Rosendaal* and *Zevenaar.*

At *Zwolle* and *Amersfoort*, the final signalling installations are dependent on alterations, which are to be made to the track.

Maastricht.

At *Maastricht* the damage was not so great. The 7 row power frame in box T had been rather badly damaged by hand. The State Mines factory lent very effective assistance to the work of repair which we gratefully acknowledge.

The other signal boxes were, as far as possible, restored to their original condition.

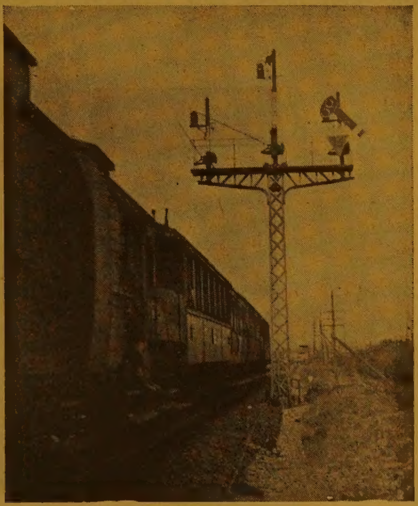


Fig. 7. — Drawahead signal on platform at Apeldoorn, in « off » position.

Utrecht.

Utrecht also suffered badly, not from heavy damage but from serious pillaging. The attempt to steal the 7 row power frame, intended for the south region of the layout, which was found still in packing case, did not succeed. It was recovered on Netherlands territory at Enschede. Fortunately the installations at the Central Station only suffered minor damage. It was in fact very necessary for the re-establishment of the train service, especially at the outset, that the signalling at this central

point should be ready to function as fully as possible.

In this category may also be placed the stations at *Breda, Zutphen, Tilburg* and *Watergraafsmeer.*

The sections of line the most seriously damaged from the signalling point of view were : *Roermond—Sittard, Rosendaal—Flushing, Amsterdam—Nieuwersluis, Rotterdam—Dordrecht, Beugen—Blerick, Amersfoort—Hattemerbroek, Venlo—Roermond* and *Eindhoven—Blerick.*

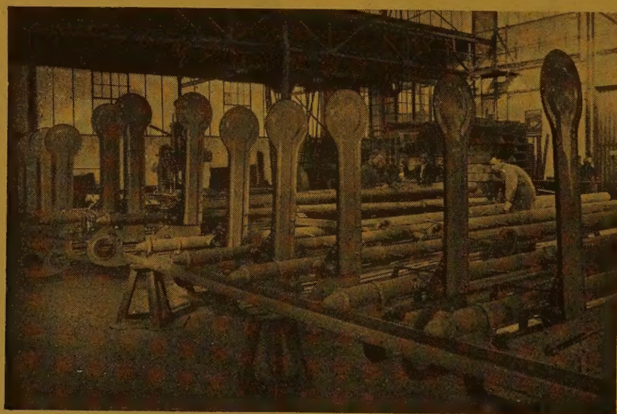


Fig. 8. — Semaphore signals under construction.

Among the places heavily damaged in 1940, we must mention also, besides *Zwolle* and *Amersfoort :*

Deventer, Rotterdam, Groningen, Leeuwarden, Onnen and *Apeldoorn.* The value of the damage incurred at the stations and on the sections of line mentioned comes to from 400 000 to 500 000 Netherlands florins per case; taking 1939 prices as a basis.

The most up-to-date of the automatic signalling installations are those between *The Hague and Voorschoten,* and *The Hague and Loolaan* (South Holland Electric Railway). (Alternating current automatic block with colour-light signals.) These were less damaged than the others and could quickly be restored to working order.

Thanks to certain parts being available from the *Gouda—Oudewater* and *Utrecht—Vleuten* (alternating current block with semaphore type signals) sections, it was possible with the aid of certain other components to re-establish the automatic working between *Utrecht and Vleuten.*

On the *Gouda—Oudewater* section ordinary manual block was provisionally installed, with an intermediate block post at Hekendorp.

The *Boxtel—Best* section, equipped similarly to the two just mentioned, was in the same state as the *Utrecht—Vleuten* section and also could be put into service again quickly.

Between *Watergraafsmeer* and *Weesp* ordinary manual block was installed with intermediate signal box at Muiderstraatweg, as on the *Gouda—Oudenwater* section.

Tilburg—Gilze-Rijen (direct current installation with semaphore type sig-

nals) was not destroyed. This section was urgently needed by the Allies, who provided any material wanted to get it into service again.

Dordrecht—Willemsdorp was heavily damaged and is now, as part of the electrification, being re-installed on modern lines.

The *Berkum—Dedemsvaart* section was seriously damaged and pillaged.

Repairs were effected with the aid of materials recovered from other sections.

After the liberation of the Southern and Eastern Netherlands.

Immediately the South had been liberated, the staff took stock of the position and devoted itself wherever possible to the first essential repairs. Bombardments sometimes compelled them to take shelter when projectiles fell and damaged once more the newly repaired equipment. In numerous instances the heaviest damage such as that caused by aerial attacks on signal boxes and points and crossings had taken place only the day before.

Fig. 9. — The first step is to verify the condition of the parts of a lever frame.

First attempts at reconstruction.

At the time of making the first attempts to get things going, followed by the installation of temporary safety appliances, the district signalling staff, with the signal engineers at their head, put forth all their best efforts. All the repair and reconstruction work which could be effected on site was carried out by them with the assistance of technical staff, leaving the central office staff to devote its attention to designing and working out signalling arrangements for which new equipment had to be planned and obtained.

As an example of other dangers to which staff were exposed may be cited certain cases where, after the erection of the posts for the telephone line wires, mines were encountered. In one case no fewer than 27 were counted !

On one occasion, men moved throughout the day in a mine field and it was established that the mine were of a type intended to be set off at a distance.

In every available way and with the aid of the simplest appliances the first repairs were effected. For example, a

telephone exchange was fed from a motor car battery obtained with great difficulty. A locking frame, bare of all fittings, was rebuilt with the aid of old components obtained from Belgium and made into a temporary frame.

In order to give a idea of the lack of equipment obtaining at this time in connection with the telephone communications at several places it will suffice to say that not even a simple soldering iron was to be had.

By effecting a real scramble to collect bits and pieces on all sides provisional operating frames for working the points and signals were got together with the aid of parts recovered from such sources as motor lorries no longer serviceable, etc...

At Zwolle, it was necessary to take a lorry, morning and evening, across water in order to garage it.

To convey telegraph poles a cart was hired but when the vehicle did not arrive, it was learned that the horse needed a shoe. It was intimated that if the person in charge of the signalling could provide some nails matters could be arranged !...

Fig. 10. — The components are then assembled.

Collaboration with the Allies.

When the first work of restoration was being effected in the South, several less well arranged examples of « collaboration » were noted. As in general elsewhere, in order to re-establish the railway service the first thing to do was to get telephone communications working again. Our staff proceeded therefore as quickly as possible to put the telephone line wires into working order. This was, however, often prevented by the Allies, who feared spying and even ordered a cutting of wires only just restored. Thus for example, the English had sanctioned the erection of a telephone line. The Canadians who did not wish to see a means of communication they could not keep a check on cut

it immediately. The case also arose where the Allies in setting up a telephone line met one belonging to the railway. They cut this and made use of it thence to the point where they had to leave the course of the track. At this point they cut the circuit again and continued onwards to put up their own equipment. In this way our own line circuits were considerably interfered with and after ascertaining the cause we re-established them. However, it came about sometimes that such sections changed user several times. In Limburg, we were not even authorised to establish or repair means of communication. Where this had been done the lines were cut and the poles used for firewood. On the other hand the « Royal Signals » which were to set up these lines, always rendered us complete collaboration, such that we owe them great gratitude for their help in the form of men and materials, which we were in want of during those early days.

The putting in order of the level crossings was also not without its difficulties.

By reason of the very intense road traffic on the eve of making the Rhine crossing when, both by night and by day, columns of motor lorries encumbered the roads, often in double file and with insufficient lighting, it several times happened that level crossing barriers, newly erected, were destroyed again the following day. Certain barriers had to be renewed several times.

In South Limburg, the Americans assumed command of things after the liberation and the result was that provisionally we could not do much there.

Fig. 11. — Erecting shop, showing lever frames and block apparatus mounted above them.

In North Brabant, our first step was also the re-establishment of certain telephone communication lines. Then the small stations were restored as quickly as possible with often, at the large stations forming termini for certain sections of route, the existing block apparatus, functioning as a block telegraph without any interlocking with the signals at those places, where the work could not be effected so rapidly. The *Boxtel—Best* automatic signalling remained out of use; that between *Tilburg* and *Gilze-Rijen* had to be put to work,

as already stated, as fast as possible, for the use of the Allies. They attached such great importance to the re-establishment of that signalling on this section that they provided the materials required to do it, which allowed of the apparatus being put into service very quickly, if only with the aid of dry batteries supplied by them.

Train staff system.

We also for a short time made use of the English train staff block system on the connecting lines laid down in the South after the liberation (Wijchen-) Canal Meuse-Waal—Heilig Land junction (-Groesbeek) and (The Nijmegen-) Mook junction—Hommersum junction (-Goch). These lines are at present out of use and consequently this system of block.

As far as we are aware it has never hitherto been used in our country; certainly no system similar to that applied in the present case with instruments, magnetos and bell, and a system of locking by which a staff can only be withdrawn from the apparatus by a release given electrically.

A train staff system in its simplest form (a staff being provided for each section of line which has to be in possession of the driver of any train running in that section) has been applied by us, when our railway system was in state of disorganisation, in the form of a token where, on single line sections, no telegraphic communication existed.

Behaviour of the staff.

The situation in which the staff found the offices and workshops when it again assembled was extremely trying. Often the roof was almost gone and everything had been carried off. In one case the contents of an office of a permanent way supervisor had been added to: it had evidently been used as a dormitory by someone and the occupants had installed fixed lavatory equipment.

In some cases the telephone exchanges had been removed from the stations and installed in some place in the town, for example in a police station, with very primitive cable runs from the railway station to the new location. Plainly the occupants were afraid of the stations being bombed.

During the first stage of the repair

Fig. 12. — An example to follow : youth at work !

work, examples of a high sense of duty and great courage were recorded. Thus Nijmegen was from mid-December 1944 to mid-March 1945 under gun fire. People lived in cave shelters and only ventured into the streets in cases of absolute necessity. But railway work was looked on as coming under that head. Every day men went to their work in intense cold and poorly nourished. were already working to re-establish communications which made it necessary to cross over the line of fighting on several occasions.

The wish of the staff to make itself useful directly the thing was possible was indeed very great everywhere and all difficulties and objections were set aside which we willingly describe as highly sportsmanlike.

Fig. 13. — Temporary grouped ground levers at signal box K Utrecht.

When from time to time the Canadians gave a voucher to obtain food from the Canadian kitchen, a feast was celebrated. There were no rest days. War was in progress and that was enough. In these conditions, the attitude adopted by the staff was, in other locations, too, most praiseworthy and we recall it here with much satisfaction.

There were even cases on the approach of the liberation where men

The first trains.

The passage of the first decorated train through a station gave rise everywhere to rejoicing. At Zutphen the staff staged a revue and there was a ball on the two following evenings.

The first train at Zwolle was one for Mastenbroek and the staff only were on it.

The engine was garlanded and a

group of musicians went with the train. Its reception was enthusiastic and those on the train were the objects of marks of sympathy. Throughout the day the train ran a shuttle service at public request at 0.1 florin per return ticket, the proceeds being devoted to a charitable object.

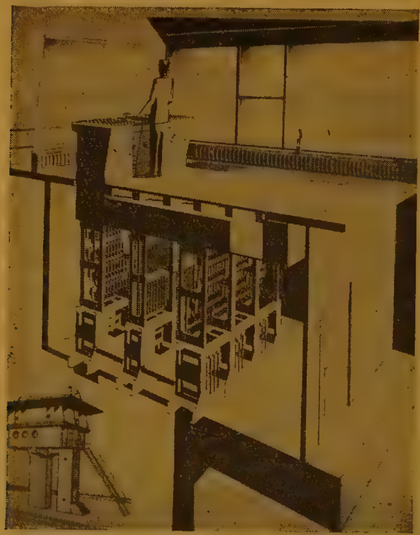


Fig. 14. — All-electric multiple row power frame.

Thefts committed by the public.

During the period of great misfortune in the country a great part of railway material being adaptable to other uses, the public naturally took possession of a great part of it and it was often the simplest among the objects concerned that caused us the greatest difficulties. Thus there was a general appropriation of signal lamp reservoirs, which caused us great difficulties during the autumn of 1945 in ensuring the lighting of the signals on sections already being run over during the evening and at night. Provisionally, we were obliged to light the stop signals only, leaving the distant signals unlighted. This could be tolerated in view of the low speeds then being run.

Accumulators and batteries were also much sought after. One case of everything being taken by the public was seen at signal box I at Diezeburg, near Hertogenbosch, which was completely demolished by the inhabitants of a gipsy camp. Many of the parts were later found again in the neighbourhood, but this was not the case everywhere. In general little was restored to us in spite of appeals made in the press and over the wireless.

Recovery of equipment and plans.

In some case equipment was recovered in a fortunate manner. We have already mentioned the case of the 7 row electric power frame for Utrecht found at Enschede. Thus at Zutphen the block apparatus from the signal box had completely disappeared but was found in the locality alongside the line. Many railway documents were recovered in the most unlikely places. The office copy plans of the telecommunications department were recovered at Haarlem in a German brake van. The plans of the line wires were handed back to us by the English. The selector apparatus of the automatic telephone exchange of the office of the General Management at Utrecht was also fortunately recovered at Haarlem, which made it possible to put the exchange into service again on May 25th, 1945, serving 30 numbers to begin with. At Haarlem, Hillegom and Utrecht, there were discovered in houses large quantities of detailed components of exchanges and telephone apparatus, which permitted, together with purchases from Sweden, extensions to be established quickly. At Zwolle, three houses were found to be full of signalling equipment. These houses had been fitted up as psycho-technical laboratories. They were connected together and with the railway station by a lead covered telephone cable. The exchange

itself had been completely modified. Apparently, the occupant had been busy « organising » up to the last moment !

A typical example was met with at Amersfoort. The signalling apparatus mechanical frames had been taken away but had been placed, all carefully numbered, in the block apparatus itself. In an electric power frame the wires had been changed round but not damaged.

Fig. 15. — Double unit colour light signal.

had been rendered useless but not destroyed. It was rapidly restored to normal. For example the plunger lock-rods connecting the route handles with the signal levers themselves (*) in the

(*) These do not exist in English signalling installations, in which route handles are never used.

There were also cases where the equipment of first necessity, such as telephonic or telegraphic apparatus, cables, wires, screws, tools, etc., had been placed in security at the homes of the staff and after the liberation came in extremely useful.

Seeing that during the occupation, but

before the strike, we had dispersed as much as possible materials and stores all over the system, appreciable quantities were available at places reached quickly at the liberation.

The Utrecht central stores, for example, had at the orders of the Germans, to be divided up at a given moment; a third was to remain at Utrecht, another third to be stored at Oss and another at Zutphen. During the last week before the strike we tried our hardest to bring to nothing, as long as possible, the order to load the reserve store at Oss and to remove it on the liberation coming near. We gained the day in this, for in the end a fully loaded train was despatched from Oss, but was only moved in such a way that the equipment was saved.

This enabled us to save a large amount of very valuable signalling equipment, which greatly helped us in the preliminary work. On the other hand the Utrecht store, following the strike was completely taken away. Little of it has so far been recovered in Germany. It is indeed difficult to find our material again, but engines and train sets are more easily discovered.

Repair shops.

Within the limits of what has been possible our repair shop at Utrecht has undertaken energetically the repair of the destroyed equipment. The Alkmaar foundry, which is well equipped to deal with our class of work, happened to be in the fortunate position of having large quantities of signalling apparatus intended for shipment to the East Indies which were very carefully hidden. The works have still some 30 new frames to supply to us and a whole series is in course of being got ready.

Help received during the first stages.

During the first stages of the work of clearing up important help was rendered to us by the Transport Department staff, which allowed our staff to travel by bicycle or other means along the line to see to the first task required.

The help given by the Post and Telegraph Department during the course of the first repairs to the magneto-telephone equipment was beyond all praise, as during later operations. At a particular moment, the number of lines borrowed from this Department amounted to 110. The Department also set up for us radio communication between the Management at Utrecht and Tilburg, Eindhoven, Heerlen and Zwolle. (We were also able to use the Police radio and Telex.) We have already dwelt on the help given by Dutch industry, the State Mines, and « Royal Signals ».

As we have already said the good will of the staff was exemplary at the outset and has not been less in connection with work to be done in the future. We may have to take a new course altogether. To economise on foreign exchange, efforts are being made to interest home industry as much as possible but this must not be done at the expense of safety in working. *On the contrary, if possible, this must be still further improved.*

PART II.

FUTURE OF THE NETHERLANDS SIGNALLING.

Protection of stations.

Let us now consider the future. As became apparent in the course of making good the damage resulting from the heavy destruction in various places, after effecting all the provisional signalling work many years must still elapse before all the large stations are equipped adequately in final form.

This being so it appeared that, in a certain number of cases where great destruction had been wrought, these final installations might be made to fit in with plans for carrying out new proposals for the equipping of such sta-

tions. As stated the Siemens (V.E.S.) firm at Berlin, sole manufacturer of our modern electric 7 row type of frame, designed for large layouts, has been dropped from our list of suppliers.

In addition, for some years past, the development of apparatus for operating signals and points has been in many parts of the world evolving in another direction.

The first appliances of this kind, three quarters of a century ago, were mechanical, and originated in the need for centralising the operation of points and signals. This, with the operation of stop blocks and bolts, and level crossing gates or barriers, was effected by means of levers, connected by wire transmissions (at first there was a good deal of rodding, of which much exists to-day in England). A forerunner of this centralised working is to be seen still at this moment at signal box K at Utrecht Central, near the old divisional offices, where the actuating mechanisms of a group of manually worked points are brought together in one place.

From this arrangement to that of levers grouped in a frame is but a step. The next and very important one was to make interlocking between these levers, so as to prevent, for example, the reversal of a signal lever (and thus the clearing of a signal) before first putting the point lever into the correct position (and hence putting the point into a position to agree with the signal) or the reversal of the levers applying to two conflicting signals. With the increase in the size and complication of such appliances these mechanical interlocking devices were in turn centralised and assembled in a so-called locking box (*).

With the introduction of electric and electro-pneumatic operation of points and signals the levers were replaced by small handles by means of which contacts were made or broken. The mechanical interlocking between signals and points was still effected by a locking box with mechanism acting on and actuated by these handles. The only difference in principle between this and the mechanical type frame is the absence of any mechanical connection between the operating handles, or knobs, as they frequently are — and the outside apparatus, which necessitates some means of detecting or proving intended to guarantee that the signals and points have in fact responded to the operation of the handles. This detecting is effected by electro-magnets actuated by contact makers or circuit controllers at the ends of the circuit.

With mechanical equipment a limit is set to the maximum distance at which operation can be effected, particularly in the case of points. This does not apply under electric working. The result is a constant tendency towards greater and greater centralisation, both in the interests of the traffic working — facility of train movement — and saving in staff required. From then onwards the power locking frames constantly increased in size and then the working became less and less easy to supervise. We had occasion to inspect in 1924, at the Grand Central Terminal of the New York Central Railroad, the largest example of this class of work, a frame of 400 levers of handles about 20 m. (22 yards) long, before which four men were stationed, while a supervising or leading signalman, provided with telephones, loud speakers and a large diagram covering the layout and carrying numbers of small indicating lamps, was constantly giving orders to his assistants. Here the limit had certainly been reached and perhaps even exceeded.

When the limit of 100 handles was

(*) In this locking box there are a number of slide bars arranged parallel to each other. By reversing a controlling handle one of these bars is moved longitudinally for each train movement and by means of notches interlocking between the bars is effected. (This moving of the bars by a special handle is unknown in England.)

passed and we saw ourselves coming to need 200, we first met the situation by a so-called two-row apparatus, with two rows of handles, one above the other. This arrangement, however, did not appear to be a good one and we developed our 7-row frame, with seven rows of handles disposed on a flat board in front of the signalmen. This Netherlands design could only be made by Siemens, who were bulding for Germany a 4-row apparatus, worked out in that country.

In the 7-row apparatus (for a lesser number of handles a 5-row design was also built), we started with the idea that it was desirable to retain the mechanical locking box, which is located beneath the floor of the signal box proper (as well as the relays and circuit controller shafts which, in an under storey, are accessible all round), in order to allow of the operating staff standing in a suitable position, as they must have a clear view to the outside of the signal box when in front of the frame. This arrangement makes for a very compact assembly.

In the meantime another idea has come from America. With a view to reducing the size of the installation the mechanical locking has been given up and replaced by an « all relay » or « all electric interlocking » in which everything is effected by the action of relay contacts.

The consequence is that the frame becomes nothing more than a form of switchboard, on which the schematic diagram of the station layout, the position in which the points are lying and the aspects displayed by the signals, as well as the occupied or unoccupied condition of the tracks, are indicated by small lamps, while the relays may be placed wherever required, independently of the apparatus. If we have to adopt this system, which appears very likely, it cannot be denied that in dispensing with the mechanical locking we are losing something which we value, seeing that the knowledge that there is a positive interdependence of the handles, especially when a fault occurs, gives us a great assurance of safety, as it does at the time of bringing the apparatus into service or when carrying out alterations. However, the layout diagram arrangement (called a « panel » in England) largely compensates for this disadvantage. In addition, habit is bound to play a large part in a matter of this kind. However, that may be, the advantages of this method of protecting and working the traffic are so great that its development is being rapidly pushed forward and everywhere engineers are working along these lines. We are in negociations at this moment for an installation of this kind at Wolfheze. An essential part of this arrangement is the « panel » just described, and this involves electrically insulating sections of track and points and connecting track relays, thereto in the same way as in our automatic block system. *The great advantage of this is that a track or a part of it, or a pair of points, occupied become automatically protected.* This does not mean that we cannot achieve the same thing with our system of signalling. In those places where, in consequence of the view from the signal box being insufficient, we have thought it necessary to do so, we have installed such automatic protection, but this principle is so much a part and parcel of the arrangement in question that it enters into every aspect of its design and working. In immediate association with this are the shunting movements. *If we decide to adopt this system we shall have to revise our method of shunting.* We regard this as a great advantage because in the matter of shunting we have fallen little by little into a somewhat indeterminate position. For many years, we applied the rule that « during shunting no pair of points should be locked ». In view of the fact that this

rule can seldom be applied absolutely, from the safety or signalling point of view, without raising the most illogical confliction of ideas, this principle has more and more been eliminated. In the latest pre-war schemes, there were more points locked than not locked during shunting movements.

Another principle of this kind (a little less poorly maintained) was « do not protect conflicting shunting movements from one another ». Here again, little of this is left to-day. Fairness demands, however, that when certain principles have become out-of-date by the passage of time the fact that they have certainly possessed some advantages should be recognised. They came into existence at a time in the development of railways when signalling arrangements were looked on somewhat as a necessary evil, which no doubt they were, and the locking of points during shunting movements would have been regarded principally at stations as a drag on the traffic and a source of delay. The development which has resulted in our modern systems has, however, radically altered this situation. Far from constituting a retarding influence although indispensable, the equipment becomes a stimulus, an essential part of our present day intense rail traffic. We need only cite in this connection the rapid succession, at intervals of a few minutes, of express trains requiring long braking distances, with the aid of multiple-aspect automatic signalling, the rapid development of shunting methods and the application of modern signalling to gravity yard hump inclines, etc. This modern signalling exercises a similar influence on train and shunting movements in stations. The tracks and points are divided into certain defined sections on a plan agreed with the services concerned, protected automatically by light signals (access to an occupied section being allowed under certain safeguards) fully controlled from the signal box and detected, the view from the box no longer playing any part in things. Fog and other conditions of poor visibility are factors of no consequence. Difficulties of understanding between the shunters and signalmen exist no longer. All this, however, calls for new rules and regulations adapted to this modern method of rapid handling of the traffic.

One new rule, for instance, might well be « an insulated section of track (with one or more sets of points) protected by a light type shunt signal, shall not be any longer than is necessary to permit a second and other movement to take place at once ». This is in order to facilitate the most rapid and convenient succession of train and shunting movements.

The latest step, from this point of view, which has been effected in the development of what the General Railway Signal Co. in the United States calls the « N-X » system.

On a « panel » showing the layout are placed buttons at certain specified places, as may be desired. By actuating a button at the spot where it is desired that a given movement shall commence (N = entrance) and another where it is intended that it shall end (X = exit) all the operations involved in the movement are effected automatically; the point set themselves in the required position, the signals concerned change to « clear » and all this is repeated on the panel.

We are negotiating for an installation of this kind at Hertogenbosch. We shall shortly be in a position to discuss with the operating and traction departments the question of introducing such a system generally.

Protection of open sections of line.

The protection of the open sections of line outside station limits will be governed entirely by the extension of electrification and the raising of train speeds.

As a beginning, it will be desirable to replace the semaphores by colour light signals in order to improve the clearness of the indications.

This, already desirable under the present speeds, will become more so as they are raised to a value for which braking distances of at least 1 000 m. (1 294 yards) will have to be taken into account. This leads us to *extending our automatic signalling,* which offers the advantage of greater reliability and an economy of time in dealing with trains as they follow one another. In addition, thanks to the adoption of the light signal, a considerable step has been taken technically and financially towards the adoption of this system. We have a permanent source of power supply and the light signals lend themselves well to automatic working. In particular, they have no moving parts the operation of which out in the open air are dependant on atmospheric conditions. Automatic signalling is all the more attractive in that by the economies in staff, which it brings about it, pays for itself, and where this is not the case there is no obligation to put it in. However, its advantages from the point of view of traffic operation are such that they deserve consideration in such cases as well.

Our most modern sections of line, between *The Hague* and *Voorschoten* and *The Hague* and *Loolaan,* on the South Holland Electric Railway, with automatic light signalling, are examples of what we have in view. They are once more in service, after having been partially destroyed. The traffic staff look on these sections generally as being the safest. The question of *protecting level crossings* is closely bound up with that of automatic signalling, seeing that a large part of the saving of staff costs comes from abolishing the intermediate block posts. If, when they disappear, the level crossings are no longer staffed, a saving is only possible if the crossings themselves are done away with (by taking the road over or under the line) or protected by automatic signals. Each case is looked into by the Engineer's Department in consultation with the Public Authorities and the Signal Department. Moreover, among the existing non-staffed level crossings, the principal ones were intended to be protected by automatic signals in due course, by agreement with the authorities.

Signal aspects.

When light signals were introduced in place of semaphores, the course generally taken was to make use by day of the night signals hitherto exhibited by the semaphores. This appeared a very simple and logical thing to do, as it meant using the same signals on the sections equipped with light signals and elsewhere (*).

This may be true for those transitional situations in which both semaphores and light signals are being used simultaneously, but as soon as the latter become applied systematically (for example along complete sections of route one after the other), it becomes possible to work out a completely new system of light signalling, without being bound to the aspects connected with a semaphore system. A typical example that we have in mind here is our aspect given by the combination of a stop and distant signal. (We may recall here that the distant signal indicates, at braking distance from it, the condition of the corresponding stop signal.) This combination originated in the case where two signals were situated at such a short distance apart that the distant signal for the second one came very close to the first.

(*) There are also arrangements which by using light signals, coloured or not, reproduce the appearance of the semaphores, in the systems known as « position light » and « colour position light » which give 2 or 3 lights in a row corresponding to the position taken up by a semaphore arm.

It is then clearly better not to place them so but to unite them, the arm of the distant signal being placed below the stop arm. Interlocking between the two is then necessary in any case to prevent it happening that with the stop signal at « danger » the distant signal below, or a short distance beyond it can go to or remain at « clear ». This would result in contradictory indications being given (Fig. 1).

If we consider the indications that can be given at present by this combined signal, or :

1) both at « clear » signifying line clear and next signal in advance off;

2) « line clear » and below that « reduce speed » with the meaning line clear but next signal in advance at stop;

3) « stop » and below that « reduce speed » meaning « stop »,

we see that we are dealing with a three-position or three indication signal which, in English speaking countries and many others, is formed of one arm and one light. If we start from the principle that the distance between the warning or distant signal and the stop signal is at least the greatest minimum braking distance, which has to be taken into account by trains travelling in the section, the three meanings of this three-position signal are precisely equivalent to those of our combined signal. (So as not to create a confusion of ideas it would be preferable in what follows to use the term « full speed » or « authorised speed » instead of « line clear »). (Fig. 2.)

Then the three meanings become :

1) « full speed » (and *if there* is a following signal that also shows « full speed »);

2) « full speed » but stop at the following signal;

3) « stop ».

And indeed to speak in terms of the colours of the lights :

1) if one wishes to show « *green* » why should one show a second « *green* » serving no purpose ?

2) if one wishes to give « *yellow* » why should one diminish its significance by showing « *green* » above it ?

3) if one wishes to show « *red* » why should one diminish its significance by showing « *yellow* below it ?

If we note too that the light signals on the automatic sections between The Hague, Voorschoten and Loolaan are three-aspect signals (that is to say that one light unit can, by means of an electro-magnet which moves a spectacle in the signal show three colours) it is natural that when it was desired to provide combined aspects it was proposed to do so by using the three combinations offered by a single unit of this kind rather than employ two such, with one aspect in each not utilised. For reasons of principle this proposal was not agreed to at the time. At present, being as we are about to apply these signals on a large scale, it would not be logical to use less satisfactory and more complicated combinations and hence a number of double lights. In automatic signalling notably where we are free to place the signals where we like, as regards distance between, we have a very simple means of meeting any objections of principle. We have already referred to this above. If the distance is at least equal to minimum braking distance (fixed provisionally for high speeds at 1 000 m. [1 094 yards]) the problem is solved. In such a case the meaning of the single *yellow* light can be expressed without any inconvenience as « full speed but stop at the following signal ».

The distances at which our present distant signals are placed in rear of their stop signals do not in fact always satisfy the condition of allowing full speed on passing them at *yellow*. The

fog approach warning boards and the length of overlap laid down in the rules counteract completely this small disadvantage, should it exist, but as already stated, this is not to be taken into account when extending the automatic signalling. The first alteration in our signal aspects which would call for consideration is the *introduction on the sections of line concerned of the three aspect signal* (*).

Although the reason for using the warning board may be somewhat diminished by reason of doing so, it has been such an important element in our signalling history that to *keep it seems equally called for in this case.*

Then, at least on those sections where the distance between two automatic stop signals does not become too great (up to say about 3 km. [3 280 yards]) it is possible to adopt the principle of what are called « running signals », that is to say each signal carries also the distant signal for the next in advance; this arrangement forms the most complete application of the 3-aspect light signal (Fig. 2). (Strictly speaking the expression « running signal » in England means any signal that governs a train, as distinct from a shunting or draw-ahead movement).

Each signal is then in a condition to show three aspects and thus be utilised to the full. Practically, this comes down to placing the distant signal at half the block distance. To fix our ideas, in a 3 km. block section, at 1½ km. from the following signal. (In automatic working the placing of the signals from the cost point of view is of no real concern.)

(*) For the sake of completeness we would mention that we have known a few applications on the Netherlands Railways of the three position (3-aspect) signal; on some bracket type semaphore posts at Lage Zwaluwe and on some light signals at Koningshaven bridge. For reasons of principle, already mentioned, these signals have been done away with at these places.

The number of signals remains the same, but *the distance between trains* (with speed reduction on meeting the *yellow* signal) *can be cut down to one half,* or 1½ km. instead of 3 km. From this come the expressions « running signals » and « keep trains moving ». In fact, the advantages of these signals are indicated by that very fact, reduced intervals between trains, fewer stops, easier running for the train crews on account of longer braking distances between signals, without increase in costs. We only know one disadvantage, but that easily disappears in face of the advantages. On account of the longer distances between a *red* signal and a *yellow* preceding it, there is a slight chance in times of poor visibility due to atmospheric conditions (fog) that a *red* signal is being expected when it has in fact already changed to *yellow* after the train has passed the preceding *yellow* (for the signal is of course passed earlier than it would be if placed exactly at braking distance from the signal ahead). For this reason it may be undesirable to adopt this system in those cases where the block section lengths are too great, or else to *sanction the expense of putting in an additional signal* in order to obtain the benefits of this system. Once the costs of automatic signalling are accepted at all those of installing an extra signal are not high. (It is to be noted here that the importance of the warning board on sections so equipped is reduced : its abolition could be contemplated and this would emphasise so to speak the character of « running signals » [longer braking distance].)

Speed signalling aspects.

A second and very important problem deserving of consideration when a general application of light signals is being undertaken is the arranging of the signal aspects at junctions between stations and at stations themselves, so as to in-

dicate to the drivers the speed at which they may run. Here again at the outset what was done was to make the light signals give the same combinations of aspects that the semaphores had done. The most general form met with is the bracket type post with high and low « dolls », as they are called, placed side by side, with a junction distant signal in rear preceded by a warning board.

Fig. 3 shows the different signal aspects. The higher « doll » or post at « line clear » *(green* light at night) indicates « full speed ».

The corresponding aspect at the distant signal is one arm vertical, the other raised to 45° (two *green* lights side by side). When this home signal appears at the entrance to a station, it has to be completed, in our modern signalling, by a distant signal for the starting signal or « inner distant », with warning board, either immediately following the bracket home signal or placed below the arm on the higher doll on the bracket.

(Which of these arrangements of aspects is used depends on the distance between the home and starting signals.)

If a through run is free to be made at a station the (inner) distant signal shows a *green* light as well as the starting signal.

When the lower doll on the bracket indicates « line clear » *(green)* that always means « line clear » for a diverging track at a maximum speed of 45 km. (28 miles)/h., the direction of deviation being denoted by its position to the right or left of the higher doll. The aspect corresponding to this shown by the distant signal in one arm at 45° in the upper quadrant, the second at 45° in the lower quadrant (a *green* light and a *yellow* light side by side). In certain defined circumstances, when it is necessary also to be able to run through the station on the diverging line (at a maximum speed of 45 km./h.) a distant signal for the starting signal may similarly be placed below the home arm on the lower doll.

It is evident that it is not at all necessary when adopting light signals generally simply to use again with them the indications given by semaphore type signals, quite independent of the fact of maintaining by so doing some disadvantages of such signals, which are inherent in them. However this is what was done everywhere when this change was first made and it is understandable. Fig. 4 shows the results of so doing, giving, as it does, in the form of a table an outline of what has been done in a certain number of countries when reproducing the semaphore aspects as light signal aspects. Anyone unversed in the subject would not find it easy to draw from this table any general rule, for even the expert would not find it easy, and indeed possible for him only by taking his mind back in each case to the mechanical type signals and the history of their development. What is particularly surprising, for example, is to see « red » in a « line clear » combination, a necessary evil (*) in combined semaphore aspects to which one has become accustomed everywhere but which is unnecessary with light signal aspects and therefore not justified. For this reason a commencement is being made in several countries in cases where something special is being aimed at (for example for « multiple-aspect » indications) to arrive at solutions to the problem by using light signals without « red » appearing in any combined aspect indicating « line clear ».

A question which then arises is this : is it necessary to indicate in the aspects the diverging routes by means of sepa-

(*) In Germany, it is true, an endeavour has all along been made to get rid of this disadvantage in principle attaching to semaphore type signals by concealing the unwished for « stop » aspects, but this gives rise to great complications and severely restricts the possibilities of the arrangement.

rate signals mounted side by side, and is the indication of the actual direction taken by the deviating track important?

As a matter of fact practice has already supplied the answer to this question, in the majority of countries and in the Netherlands too.

If the object of our junction aspect originally was to provide a clear indication of the form of the junction, bringing out at the same time the speeds applying to the various routes, in the course of time it is the indication of the speed which has become the more important in practice. Alterations have therefore been made in our Signalling Regulations under which the indication of the speed has in certain cases superseded that of the route to be followed. For example, the distant signal in rear of a junction is able only to give a speed indication. This results in a certain dual character in our present signalling which ought not to be allowed to reappear in any new light signalling system. Throughout the world a tendency is noticeable to make the *signal aspects* represent the allowable speed. Now that we are about to generalise the use of light signals it appears appropriate to consider completely anew the signal aspects and submit whatever system shall then appear preferable to a practical trial for a certain number of transitional years, side by side with the old system, and to have in mind possibly some temporary or permanent concessions covering modifications thereto during the change-over period.

For this purpose we can lay down a certain number of principles which a new system must comply with.

These may be, for example, the following :

1) When more than one speed requires to be indicated at a given signal post, an equivalent number of signal units (one per speed) are to be placed one above the other, the uppermost applying to the highest speed, and so on.

2) In a combined aspect *red* should not appear at the same time as *green* or *yellow* and *yellow* (as providing a warning approach to *red)* should not appear at the same time as *green*.

3) In a combined aspect not only the authorised speed applicable where the signal post is placed should be indicated but at the same time the speeds applicable at the following signal, unless such speed shall be higher than that indicated at the first signal.

(This arrangement takes into consideration the fact that each reduced speed indicated by a signal shall be announced by the signal in the rear, on the principle of the distant signal. The opposite course is undesirable because, from the psychological point of view, it is wrong to cause a signal to indicate that at that point a train must run at reduced speed while the following signal is authorising a higher one.)

4) In close connection with 3), it is necessary that :

a) « line clear » shown by the upper signal unit shall indicate always the speed permissible at the point where the signal is located;

b) the second signal unit showing « line clear », seen simultaneously with that mentioned in *a*) but in a lower position shall indicate the lower speed which the next signal is calling for.

c) if only a single signal unit is showing « line clear » in a combined aspect such shall form a combination of *a*) and *b*) that is to say it shall indicate the speed at the signal itself and one at least as high at the following signal.

5) *a*) In a combined aspect shown by a *home* (or it may be possibly outer home) *signal* at a station it is desirable that the *lower signal unit shall not impose a speed above 45 km. (28 miles)/h.* in view of the need of protecting any tracks in the station over which this limit is laid down;

Fig. 1.

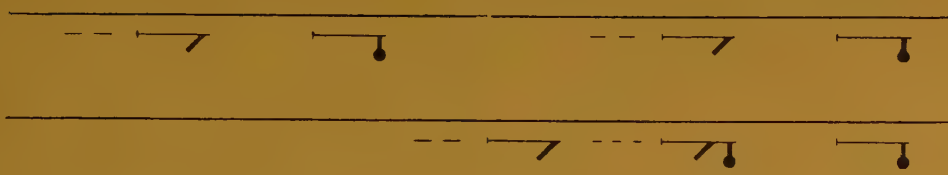
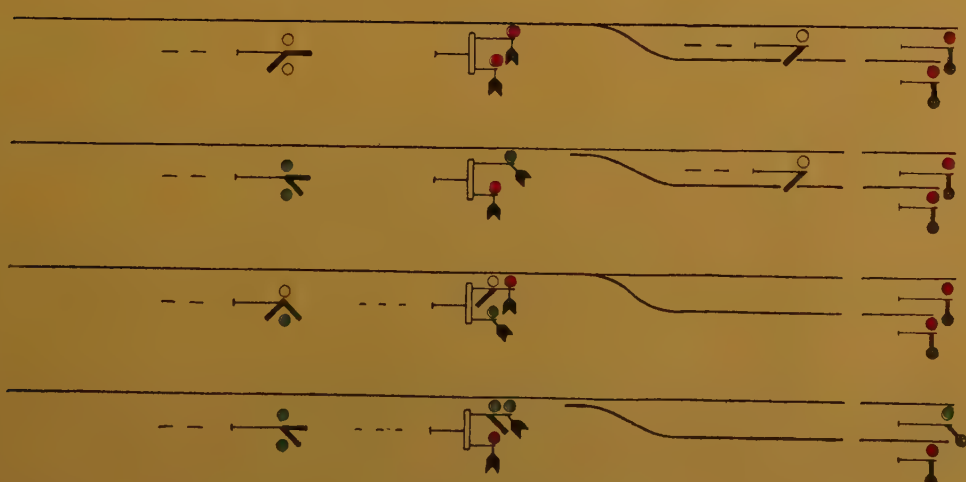
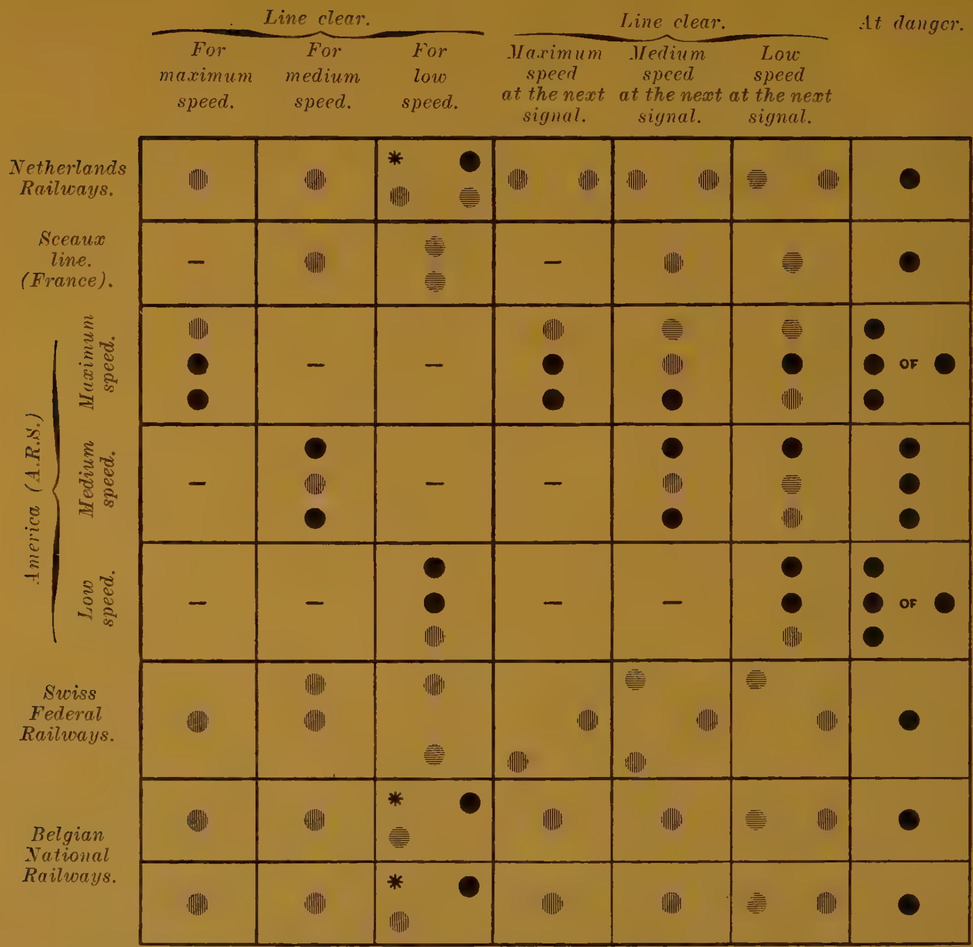


Fig. 2.

Fig. 3.



Note: Of = or.



* *Here the direction is indicated at the same time.*

Fig. 4.

Note : In this figure as well as in figures No. 5, 8, 9, 10, 11, 13, 14, 15 and 16, the signal lights represented by *black dots* **are** *red* **lights; the signal lights represented by** *vertically hachured circles* **are** *green* **lights; the signal lights represented by** *horizontally hachured circles* **are** *yellow* **lights.**

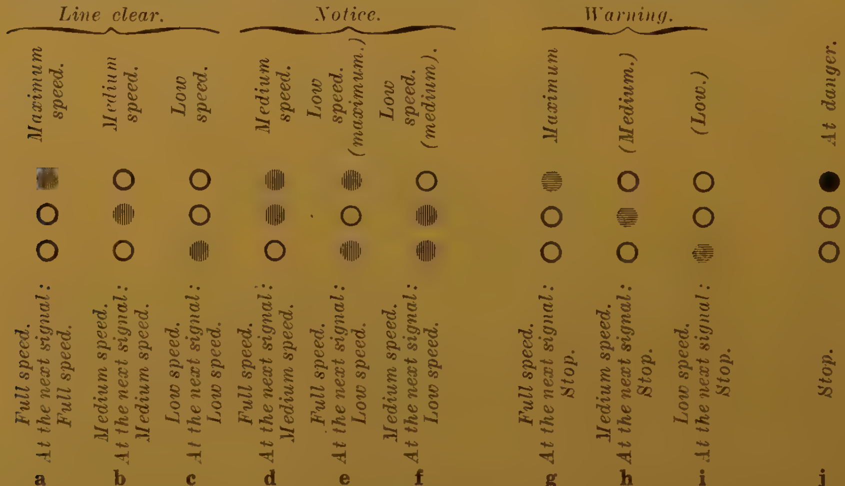


Fig. 5.

Station for maximum speed.

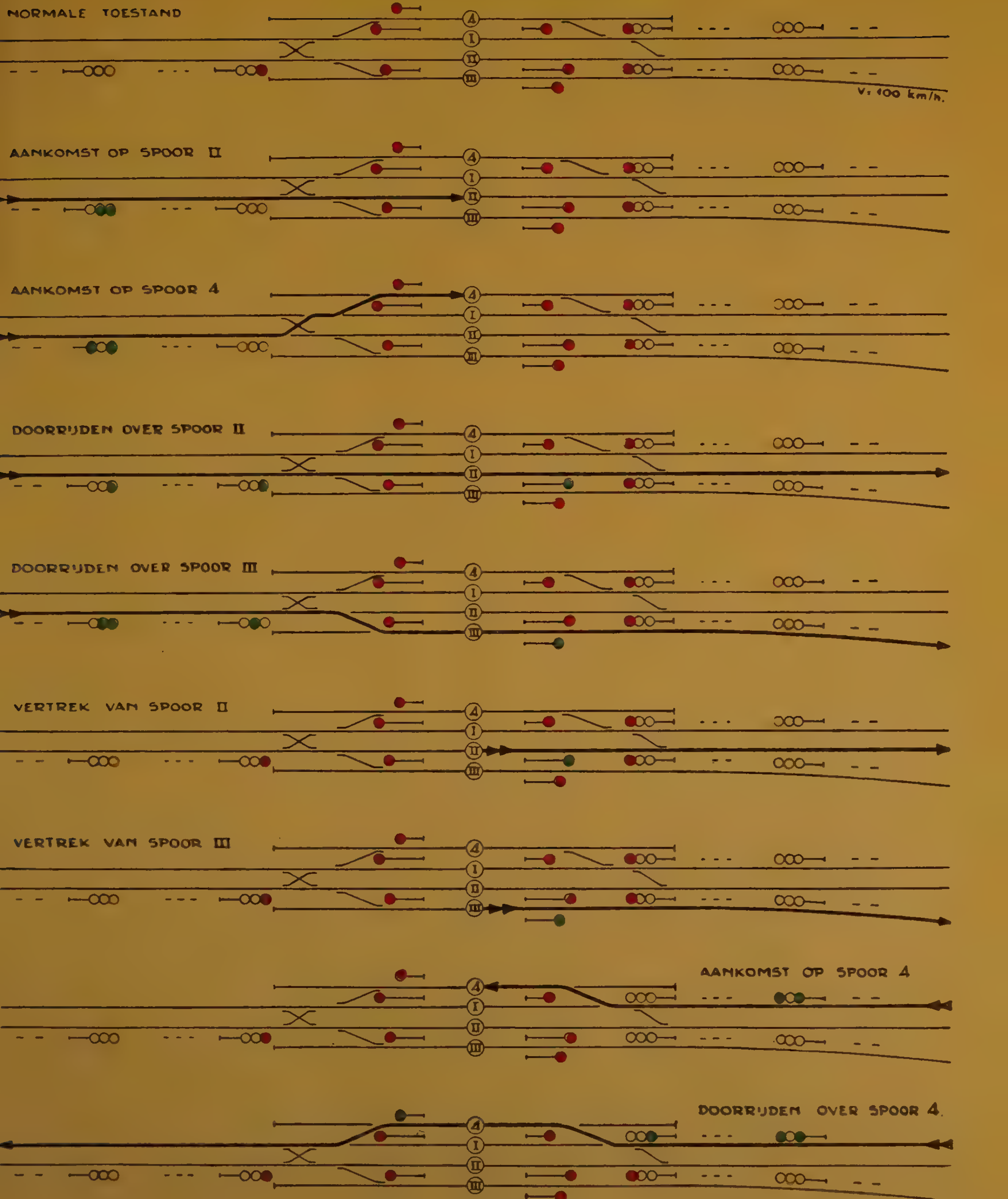


Fig. 6. — Light signals.

Explanation of Dutch terms:

Normale toestand = normal situation. — Aankomst op spoor II = arrival on track II — Doorrijden over spoor II = passage on track II. — Vertrek van spoor II = departure on track II.

Fig. 7.

Fig. 12.

Note: b. v. 1 500 m = per ex. 1 500 m. (1 640 yards).

b) in a combined aspect shown by a *home* (or *outer home) signal* it is desirable that the upper signal unit *shall not call for a speed less than the maximum* allowed on that section of the line;

c) as a consequence of *a*) and *b*), it is desirable to have in a combined aspect shown by a *home* (or *outer home) signal* a *central* or middle speed aspect, « medium » (the meaning of which may vary with local conditions and hence be laid down in the regulations), but which should be kept preferably between as close limits as possible. In any case such limits ought to be such that if by mistake a driver should run through a station at the upper limit of speed when the lower is called for no derailment shall be possible in consequence at the curved part of the turnout.

(In the present system the conditions set forth in *a*) are complied with but those in *b*) and *c*) are combined and thus the less desirable condition obtains that with the upper signal unit showing « full speed » the figure allowed can be reduced by a board imposing a restricted speed which can vary between 125 and 60 km. [78 and 37 miles]/h.)

In laying down the conditions 5 *a*), *b*) and *c*), we arrive at a *home* (or *outer home) signal* which is able to show a three-unit (three level) aspect, something which would meet practical working conditions even if the speed should be put as high as 150 to 160 km. (93 to 99 miles)/h.

In wishing to impose the condition that « medium speed » shall be accurately defined, we should be losing sight of the practical possibilities involved, seeing that to do this at all those junctions when a « medium » speed higher than such a figure could in fact be allowed, we should be obliged to call unnecessarily for a lower figure, and also because on the other hand many junctions would have to be laid out to permit of a higher « medium » speed, which is impossible in practice.

The purely theoretical solution to the problem would be : as many signal units on the post as there are speeds laid down, which already would mean one for each rise in speed of 15 km. (9 miles) between 45 and 120 (125) km. (28 and 74 [78] miles)/h., and later 150/160 km. (93/99 miles) /h. Naturally such a solution is not one that can be contemplated as possible.

However a system in which the minimum and maximum speeds are fixed and the medium one is variable would in our opinion satisfy all reasonable requirements, even for a very long time.

(In addition, the system lends itself to being extended to cover four speeds [signal units on the post] if this should become necessary later on.)

Practical examples.

1. In these signal aspects made up of three units placed one above the other, one, or two at most, of them must present an actual signal indication. The others serve merely as « markers » to enable the position of the other two to be determined or recognised by the approaching driver. They ought therefore to be of some « neutral » colour (not one of the real signal aspect colours, *red, yellow* and *green)*, and in order to fix the matter in the mind, we will suppose that we should use provisionally « lunar white » a colour already used for many years in America for special « marking » purposes. We are awaiting the arrival of a consignment of all those colours which have been tried in special types of light signals, from among which if need be we shall be able to select some neutral colour.

2. In the case of each light which, at whatever one of the three positions on the post it may be shown, allows a train to continue running, *green* appears to be the correct colour for it to exhibit, save as mentioned in 3.

3. *Red* is always preceded by *yellow*, indicating « caution ».

As typical examples of these three unit aspects the 10 aspects shown in Fig. 5 have been developed from what has been said above in connection with which we may note the following points from which to develop our argument.

A. The position on the post (top, centre or bottom) occupied by *green* indicates the permissible speed. When there is only one *green* showing it indicates likewise the permissible speed at the next signal.

B. When two *green* lights are seen in an aspect, the upper one indicates the speed permitted at the signal, the lower one that at the next signal.

Thus aspect *d* precedes aspect *b* with the meaning « full speed, then medium speed »; aspect *e* preceding *c* means « full speed, then low speed » and *f* preceding *c* means « medium speed then low speed ».

In the case of *red* (sometimes also in the case of *yellow)* the position on the post plays no part in the meaning and it would suffice merely to show *red* somewhere (at times *yellow).* However it is considered desirable for the driver to be able to recognise from the signal aspect that he is in an area where the three unit type of signal applies, and in the case of being stopped by a *red* light, that he is standing at a home (or outer home) signal. Each unit can give three different colours, however, and if, in the case of aspect *j* the two lower lights had to be extinguished, this would amount to having a fourth condition in a unit, namely no light. This would involve a small amount of technical complication. For this reason *red* is always shown from the top unit, for if it seems that in this case four conditions are called for in that unit, in practice this is not so. We have in fact not come across any case where in applying this system of aspects the aspect *g (yellow* showing from the top unit) is called for in a unit in which we require to be able to show *red* as well.

(It is however quite possible, should it be required, to show *red* at any time as a single unit not displaying anything else.)

Fig. 6 shows the application of this system to a hypothetical station with a number of possible train movements.

It may be useful again to point out here that we started from the idea that the three unit aspect is applied only where there is a necessity for it. Consequently it is *not used* for the starting signals where the difference in height is seen by comparing the adjacent signals with one another and serves merely to distinguish the through running lines from the others (*).

Multiple aspects signals.

Seeing that a new signalling system ought to be capable of any development likely to be thought of in the future, it becomes necessary to compare the one now occupying our attention with the development that has taken place of recent years known as « multiple-aspect signalling » already dealt with in the pages of *Spoor- en Tramwegen.*

Indeed, the three unit aspects under discussion are in fact in a greater measure multiple aspects, seeing that in the English speaking countries this name is given to a signal which can show more than three, that is to say more than the three aspects, *green, yellow,* and *red,* and in our case therefore at present more than the three indications :

green green and *green yellow*   *red* / *yellow* (stop signal with distant signal mounted below).

(*) We have also considered whether this three unit type of signal might not be used to indicate by means of the signals permanent speed reductions on lines between station limits. In principle such a thing is naturally quite possible. However it appears to us advisable not to resort to it for the moment owing to the difficulty of placing the signals and the great variety of speed restrictions met with.

Our three position, or three indication, signal is in fact at present still, as already explained, made up of two signals. This « combined » signal or indication is something different from the mere doubling, tripling or otherwise multiplying the aspect of a signal unit.

The fact that a signal is « multiple aspect » has actually nothing to do with the construction of it but has reference solely to the meanings it is intended to convey.

As there are only three colours of light, one signal unit cannot show more than three aspects, from which it results that for multiple aspects one is obliged to have recourse to combinations as in the three unit arrangement already described.

Thus, in the case of Fig. 6 the caution or distant signal (reading from left to right) shows *four* aspects, the corresponding home signal *five* (see the first five aspects at the head of the figure). (The difference between the two numbers arises from the fact that in cases 2 and 5, the distant signal shows the same aspect while those shown at the home signal vary. For these two different home signal aspects the speed shown at the distant signal and at the home should not however be different).

To fix our ideas clearly once more :

1. One light unit in a signal cannot show more than the three aspects, *green, yellow* and *red;*

2. In order therefore to show a multiple aspect, combined aspects have to be used, that is to say more than one light in a signal at a time (this has nothing to do with the fact that in our present system we make use of a triple aspect made up of a combination of two signals).

3. To avoid confusion we shall use provisionally in what follows the expression « multiple aspect signals » to cover the special circumstances of using aspects for which the term was created in English speaking countries.

There they began to use such signals some years ago on certain sections of line where they had to reckon with such a rapid succession of trains that the minimum length of the block section was not sufficient. (For this reason they might be called perhaps « multiple block section aspect signals ».)

By using a three aspect signal as a signal referring to certain track sections in a system of « running signals » (Fig. 7) it is possible by reducing the signal spacing to reduce that between the trains and thus to increase the frequency of the service.

In doing this we cannot go beyond the minimum braking distance, say for example 1 000 m. (1 094 yards). The minimum distance between two trains running at full speed when it is required that the second one shall receive a *green* aspect two sections in rear of the first then becomes, making correcting allowances for length of overlap, length of train, time taken by the apparatus to function and by the driver to observe the signal, etc., about 2 500 m. (2 734 yards).

If therefore, we wish actually to obtain this minimum distance, the signals being placed at the intervals described above, the running would become difficult to manage, for example in foggy weather. A driver finding a signal every kilometre would have to be prepared in every case to make a rapid brake application. We can also imagine circumstances under which we should have to have a shorter distance than 2 500 m. between trains, which would involve locating signals within the braking distance. This is impossible without making some modification to the signalling.

It therefore becomes necessary to use « multiple aspect signals ». In this system not only does the signal immediately in rear of a signal at stop indicate that the latter is at danger, but the signal in rear of that also shows the same aspect

when the distance between signals is less than the braking distance.

In applying the distances referred to above we have the following condition: the 2 000 m. (2 187 yards) between the first and third signal in the three-aspect arrangement shown in Fig. 7 becomes no longer divided into two but into three sections, with four signal posts instead of three, four aspects in place of three and an increase in the braking distance for the driver of 1 000 m. to 1 333 m. (1 458 yards) allowing of more flexible handling of the train, and if we wish to obtain the maximum benefit from this, of the braking distance being again brought down to 1 000 m. (Also of the distance between signals being made 500 m. (547 yards) and the length of 2 000 m. being reduced to 1 500 m. (1 640 yards) allowing of the distance between trains running at full speed being reduced from 2 500 m. to 2 000 m.

If it should be desired to go further still we can divide the distance between the first and third signal posts in the three-aspect system into four sections; we then have five signals and five aspects, and have a braking distance of 1 500 m. or, if we bring that down once more to 1 000 m. (distance between signals to 333 m. [364 yards] we reduce the 2 000 m. to 1 333 m. and the distance between trains to 1 833 m. [2 004 yards]). (It goes without saying that these distances are very approximate and theoretical.)

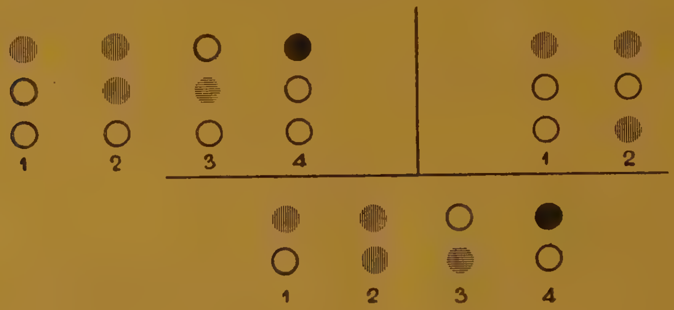


Fig. 8.

Fig. 9.

Now how we make use of the multiple-aspect three-unit system of indications, described under « multiple aspect signals » if certain sections of line in our country should in the future call for more than three aspects?

Fig. 10.

To begin with let us take a 4-aspect system, see Fig. 8. It will be seen that we have two possible ways of arranging the second and third aspects. Indeed there are too many possible ways of doing this with the three-unit system, as becomes apparent on omitting one unit from each of the four indications, which makes the two possibilities coincide.

The three-unit system thus offers the

maximum facilities in a 5-aspect system, as shown in Fig. 9. However it would be possible to install this system using. two units only, while retaining its essential features, as seen in Fig. 10. Indication 3 does not, in this arrangement, convey so plain a message to the driver as in the preceding one, because it denotes a permanent condition and does not indicate a reduction of speed.

The two-unit system becomes in this way insufficient for the requirements but not the 3-unit. (See Fig. 11 showing

Fig. 11.

a seven-aspect system.) In this case aspects 3 and 5 do not convey so complete a message to the driver, as they denote a permanent condition and no reduction in speed. The system is, however, a purely theoretical one. In fact, taking a braking distance of 1 000 m. for 160 km. (99 miles)/h. the signal posts would only be 200 m. (218 yards) apart, the distance between the first and seventh being 1 200 m. (1 312 yards) and between trains 1 700 m. (1 859 yards).

The maximum that has been applied hitherto on a short section in England and America for special reasons is the « five-aspect ».

Simplified system of multiple aspects.

We have outlined above how the characteristics of the three-unit system, designed to meet the requirements of junctions, provide us with a means of working out multiple aspects applicable to ordinary sections of line.

As regards the difficulties that may arise in doing this (and their solution), these may be due to the imperfect way in which some of the aspects applying to junctions and those applying to ordinary sections of line coincide with one another. Should a lamp fails then the three-unit becomes a two-unit system, and the two-unit becomes a single unit system, leading to a contradiction between the meaning of certain of the aspects and those at present in use. But we do not propose to dwell further on this question, seeing that we are of the opinion that a much simpler arrangement can be employed.

Going back to the point from which we started as forming the justification for multiple aspects, we take Fig. 7 and proceed to consider the 3-aspect signal once more. If the distance between signals is a minimum (that is to say the greatest minimum braking distance, 1 000 m.), the distance between two trains running at full speed (= 2 500 m.) can only be reduced by adding more signals. If we wish to obtain the maximum results in the matter of the carrying capacity of the section concerned, the approach warning for the *red* light, that is the *yellow* light, must remain at 1 000 m. in rear. All that can be done therefore is to divide the 1 000 m. in two (4-aspect signals), or three (5-aspect signals), etc.

The distance between trains is then diminished to 500, $666^2/_3$, 750, 800 m., etc. From these figures it appears that only the first sub-division into two parts (distance between signals 500 m.) offers an important result. It results from these figures that only the first sub-division into two parts, with signals 500 m. apart, produces an appreciable and important effect. From the series of aspects shown in Fig. 12, it can be seen how the aspects change as a train passes along. The conclusion we obtain from this is that we can make do in fact with three aspects, seeing that the fourth aspect can be obtained by extinguishing a signal. We have no more need than we have with the 3-aspect system of a signal indication in between the *yellow*

and the *red*. This reasoning leads us to a much simpler line of thought, namely that the situation within the limits of the braking distance, if the warning of approach to a *red* signal is being given, can, when everything is considered, be the same for any system, whether 3-aspect, 4-aspect, 5-aspect, etc. The advantage from the point of view of the frequency of the train service results solely from the bringing up of the last *green* light closer to the *yellow;* the *yellow* then changes to *green* all the more quickly, notably when the light which is *out* (or it may be the first of those which are out) and situated within the braking distance becomes *yellow,* given that the *red* light goes out because the following signal becomes *red,* in the direction in which the train is travelling.

It is not necessary therefore that the signal (or signals) passed within the braking distance, when the one at the end thereof is showing *red,* should give any positive indication. Another question, however, is this. From the moment when such signals exist, should we not in such a case make use of them ?

Certainly we can. In the first place it is not a good thing at all for drivers to have to run past signals showing no light under normal circumstances. Is the light meant to be out or is it out of order ? The fact of having passed a *yellow* signal is of itself, it is true, an indication that a signal showing no light is to be expected, at least on a section of line equipped with multiple aspect signals; nevertheless misunderstandings could arise from the use of such a negative signal, experience showing this always to be the case with signals of a *non positive* character.

We must not lose sight either of the fact that we have to take into account the most unfavourable atmospheric conditions, such as dense fog for example.

Furthermore, this negative signal is shown in circumstances in which the signalling system must answer to the highest demands : prevention of danger.

It is therefore to be recommended that we should make use of these signals to repeat the caution or warning approach indication.

But how should we do this ? We are tempted to say, repeat the warning by means of a *yellow* light. Technically and from the economic point of view this solution is attractive as not giving rise to expense or complications, for this aspect is already in existence and the signal is once more reduced to a simple 3-aspect one. However, the two warnings do not have the same significance. The first say « a *red* light will be showing at braking distance from here ». By analogy with all our other aspects now in use the *yellow* light is the one to use for this purpose.

On the other hand, the second warning says « at half braking distance from here a *red* light is showing ». If we give a single *yellow* light at this point also we can imagine circumstances in which by a misunderstanding, the driver believes that he has still the total braking distance available. In that case a signal showing no light would be preferable. There is a solution to this problem in use abroad, which consists in using *two yellow* lights and *one yellow* light, but the two are used not for the second but for the first warning. There is a very good reason for that. If one of the two *yellow* lights is out, the more restrictive aspect (« half braking distance ») is given. On the other hand, this confirms the serious objection that we put forward above, in connection with using a single *yellow* light as the second warning, while on other sections of line and under other systems of signalling, we are still using the *yellow* light to mean that « full braking distance » exists in advance of it.

If we take into account the fact that it is a question of an aspect that will only be required exceptionally on cer-

tain sections of line, whereas the single *yellow* light is in use everywhere, it seems the more practical course for these few cases to give a special light, for example the *lunar white* already mentioned or say *electric purple*. The colour can be chosen after conducting suitable trials. The aspect can be given by a separate single unit, composed simply of lamp and lens system, without any moveable spectacle inside.

On the *red* light in the three-aspect « searchlight » type unit being put out this supplementary unit would light up.

Following this line of thought we would be able, if it were necessary, to have our automatic signals set at 500-750 m. (547-826 yards) intervals for example, probably to find a much simpler solution than that of using the 3-unit arrangement for ordinary automatic signals on plain through lines (*) (Fig. 13).

1 2 3 4

Fig. 13.

Note: The light above No. 3 is mauve.

Possible change-over difficulties.

In the three-unit system the combinations *d* and *f* can give rise to a difficulty owing to the fact that our present aspect of two *green* lights, one over the other, means « line clear ». We intentionally left this difficulty out during theoretical exposition of the case so as not to complicate what we said about the working out on the basis of pure principles of the aspects which follow from our five main principles. But in the end a solution to this problem will have to be found.

The difficulty would arise in aspect *d* of the lower and in aspect *f* the upper if the light should happen to fail. Special precautions can be taken to meet the case of a lamp failing. However, it may be held that these aspects even with no faillure of a lamp differ too little from the existing « line clear » aspect. In this case the upper *green* of the two aspects (and in *e* likewise in the interests of uniformity) could be replaced by *yellow*, until such time as the present « line clear » signal (two *greens* vertically) is done away with. Although this solution could be accepted as a permanent arrangement, the *green* light aspect fit in better (see Fig. 14) in principle, and logically, with the system established on the basic principles set forth. (It is interesting under this heading to compare the American signals which are the same as those examined in this report, with the exception that *red* lights appear in « line clear » indications, Fig. 15.)

Our basic principle 2 has been drawn up intentionally in such a form that this solution (possibly a temporary one) is equally well adapted to it, for this argument would be more in conformity with the principle if it prohibited the presentation in one indication of *yellow* simultaneously with *green*, so that « when *yellow* is seen a *red* must always follow it ».

If we give up this principle altogether, naturally quite possible, we can go further still in the sense of the solution now put forward and bring under discussion an interesting variation of the 3-unit aspects *d*, *e* and *f*, in which *green* will be replaced entirely by *yellow* starting from the idea that any reductions of speed shall be denoted by *yellow*. (See Fig. 14.)

Following this order of ideas we could also form multiple aspect signals,

(*) We have already some sections of line where this problem presents itself in an acute form, for example Utrecht-Blauwkapel and The Hague (H.S.M.)-East India Avenue, especially should the greatest minimum braking distance be increased to 1 000 m.

as shown in Fig. 16, with more than one *yellow* light as the first warning indication and so on. The alteration of an aspect by the failure of a lamp is not dangerous in this case as it gives rise to a more restrictive indication. The principal objections to this system are :

1) the transitional period during which a driver meets everywhere *yellow* with a different meaning to what it has in the new signal aspects;

Fig. 16.

2) in relation with the foregoing, the difficulty of applying so simple a signal to 3-aspects, accepted as normal in a great part of the world.

or

Fig. 14.

Fig. 15.

United States of America.

Automatic train control.

When considering the future of the signalling we cannot leave automatic train control out of sight, a subject we have dealt with in *Spoor- en Tramwegen*. Under this expression we understand that a train will be stopped automatically if a driver does not obey, or obeys too late, the order to stop given by the signals. All kinds of means have been tried to resolve this problem, always keeping in the forefront the necessity of not weakening the vigilance of the driver and therefore of giving him a means of preventing the apparatus from functioning by taking some definite and effective action. A device which records the working of the equipment forms part of it.

From the point of view of principle, we can distinguish between mechanical, electro-mechanical, optical, audible and inductive systems. Among the inductive systems only a few are correctly designed from this point of view. To make ourselves clear, we will return to the old question of what is called the « closed circuit ». This can be defined as follows : « *the absence of current in any part of the signalling installation (for example in a relay) must mean that the signal concerned is at stop* ».

There are clearly some systems which

answer partially, a few in considerable measure, to this desideratum. There are, however, only a few which conform to it in as perfect a manner as does our automatic block signalling system or automatic level crossings warnings and which for this reason possess a certain importance and interest for us.

These are three American and one German systems : the last named designed by the V.E.S. (Siemens and Halske, Berlin) on the lines of one of the American systems.

With the aid of these three systems and by the very nature of the question, we achieve even more than this. The principle of the « closed circuit » implies a permanent means of proving that all is in order and this in turn becomes transformed into automatic control of the train and a permanent check on the speed.

By simpler systems conforming in a lesser measure to conditions of principle, we obtain at the outset no more than the automatic stopping of a train which over-runs a signal at stop, which, for braking distances of 1 000 m. and more is much too late. For this reason the coming into action of the apparatus is arranged to take place at the distant, or warning, signal, when it is against the train. This is the correct thing to do but as things are our difficulties now begin. What ought we to do at such a distant signal ? Apply the brake in all circumstances ? In that case the great majority of trains would come to a stand too soon. All sorts of means have been tried for meeting this difficulty. For example the coming into action has been delayed for a certain interval after passing the caution signal only, but for what interval given the varying speeds of the trains ?

Another idea tried was to release the brakes at some pre-determined reduced speed. An important improvement was effected by checking the speed at three intermediate points between the distant signal and the stop signal (« intermittent » system).

Finally a decisive step was taken by arranging a permanent check on the speed throughout the distance between the two signals, when the distant signal indicates that the stop signal is « on » (also when the distant signal, in consequence of some emergency returns to *that* condition after the train has passed it).

There being in effect an automatic connection between the condition of the track and the train these systems are sometimes completed by the addition of cab signals, or small luminous repeating signals, placed on the locomotive or in the cab or driving compartment, reproducing the indications given by the line-side signals.

Briefly expressed these three systems function as follows :

1) *Two speed system.* The existing automatic signalling track circuits are made use of, the magnetic field developed in the rails inducing currents in receiving coils on the locomotive, situated in front of the leading bogie wheels, which currents are amplified and energise a relay. When the locomotive enters the section between the distant and stop signal, this relay becomes de-energised if the latter is at stop.

In conjunction with a speed checking mechanism, the application of the brakes becomes regulated automatically from this moment on. In this system, the maximum permissible speed is checked continuously and where running at a reduced speed is permitted in an occupied section (permissive signals), this restricted speed is checked in like manner, the brakes being applied should the driver exceed it.

2) A *similar system* manufactured by a competitor.

In addition to the track circuits a supervisory or « proving » current circulates in parallel with them in the

receiving coils, one for the normal track circuit current (to prove track occupied or clear), the other for the permanent « proving » current covering the section between distant and stop signal. Otherwise this system is the same as the one described above.

The V.E.S. system is substantially the same.

3) *The « code » system.* (Developed by the same makers as No. 1.)

In this case the normal automatic block circuits have the current in them interrupted a certain number of times a minute (code) in accordance with the state of occupation of the track ahead of the train. It is in this way possible to give up to 5 different codes and so regulate through 5 block sections the speed of the train. These codes are picked up by the locomotive receiving coils, amplified and decoded to bring about the desired action. This appears to be the most generally used system but it is also the most expensive.

And this leads us to discuss the possibility of introducing it on the Netherlands Railways. We look forward certainly to the introduction of some such equipment whatever the system may be and we can do the same with respect to a number of things in this sphere. At the moment the « two speed system » seems to be the most suitable, the most correct in principle, and the cheapest. However, we do not expect it to be adopted in the near future, seeing that so many urgent things still remain to be attended to. In this connection, we recall the controversy brought about in America about 1930, when the Interstate Commerce Commission laid down that within a period of 5 years automatic train control, using various systems, should be applied on a large mileage of route. After that a relatively long delay in the matter took place and when shortly before the war the subject was discussed in a Congress held in America concerning the results obtained, the majority were of the opinion that it was better to use what funds were available to improve the signalling generally by installing automatic signalling, protecting stations (so as to detect when tracks there are occupied) etc., as by these means it is possible to be assured of obtaining immediately more important benefits from the point of view of reducing the accident figures. It was only afterwards that the extension of the automatic train control system had to be considered.

* * *

We have now reached the end of our account of the plans for the future concerning our signalling and our provisional investigation of the question of what aspects to use in colour light signalling.

May the results restore the signalling of our Netherlands Railways to its old safety level and permit them to meet the bigger and more onerous demands of modern traffic operation, namely greater frequency of train service and high speed.

[621 .335 (.44)]

BB 0401 locomotive of the French National Railways,

by J. TROLLUX,

Director of Traction Department of the Alsthom Company.

(*Revue Générale des Chemins de fer, April 1947.*)

I. General particulars.

The electrification programme of the French Railways, which was adopted by the Public Authorities on the recommendation of the French National Railways, includes many hundreds of BB type locomotives which are the type of engine most commonly used on the lines already electrified.

In view of the size of such a programme, it appeared essential that the design of a BB type locomotive should be undertaken.

The object of this was three-fold :

1) to improve the working characteristics and so increase their field of operation by improving the driving arrangement and also the comfort of the crew;

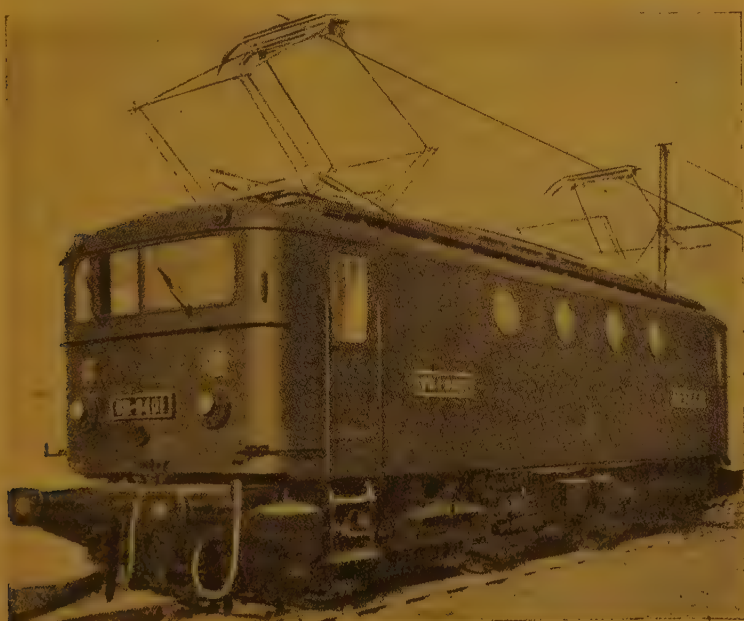


Fig. 1. — General view.

2) to reduce maintenance costs, which are already very low with the BB locomotives in service, and increase availability;

3) to adapt drawings of details of the new locomotives to facilitate manufacture.

When our designs were sufficiently advanced, the French National Railways gave not only its approval but every encouragement to undertake, at the end of 1943, the manufacture of a prototype. Owing to innumerable difficulties, the construction could not be begun until the Spring of 1945 [1].

This BB 0401 locomotive (fig. 1) is, at the present time, undergoing trials.

The following description will be divided under the above headings.

II. Working characteristics.

a) CHARACTERISTICS. — In order to increase the utilisation of the new engines it was necessary to increase both their power and their manœuvrability, especially as the French National Railways had decided that the load per axle should be increased from 20 to 23 t. (19.684 to 22.63 Engl. t.).

The investigations made showed that the motors used for the preceding series would not be suitable and it was necessary for a new motor to be designed for the BB 0401.

The adoption of half tension and compensating coil motors has enabled the continuous power developed to be increased from 475 to 600 H.P. for the same weight and to increase the tractive force at the wheel rim at high speeds in the same proportion.

Figure 2 and the following table give the principal particulars of the BB 0401 locomotive :

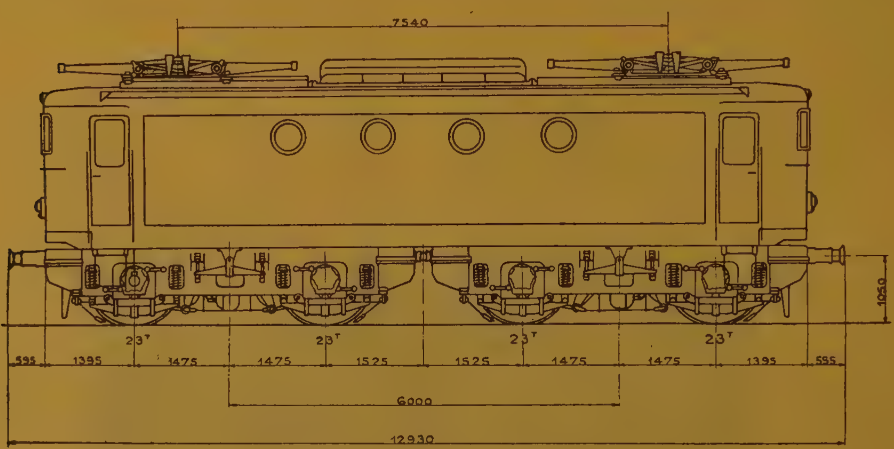


Fig. 2. — Principal dimensions.

(1) The staff of factories in the Belfort area were still being deported in large numbers when Paris was already freed. In addition, the Germans had pillaged our factories, taking both machine tools and raw materials during the weeks which preceded the liberation of Belfort by the First Army.

Type	BB with attached bogies.
Type of Motors . .	MIT.
No.	4.
Diameter of wheels .	1.400 m. (4' 7 1/8").
Gear ratio	4.14.
Continuous power under 1 350 V.	2 400 H. P., 44 km. (27.34 miles) per hour, 14 700 kgr. (32 407 lbs.) at the wheel rim.
Max. speed in service	115 km. (71 miles) per hour.
Total weight in working order:	(without ballast 90 t.). (with ballast 92 t.).

the field to 76 % (whilst protecting the motors against flash-over) whereas the motors used on the previous BB type were limited to 60 %.

This has resulted in a very important increase in the flexibility of the motors (speeds at minimum field and maximum field for the same current), also at continuous rating this flexibility, which had not exceeded 1.65 up to that time, attained 2.32 for the 0401 locomotive.

b) Field of operation. — The uses to which this locomotive can be put are increased owing to the fact

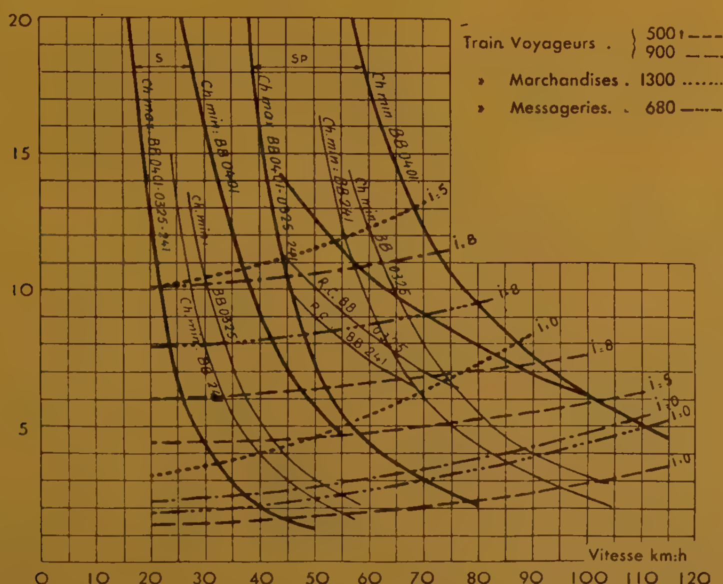


Fig. 3. — Characteristic force and speed curves with BB 241 and 325 locomotives.

Figure 3, which is a graph, shows the force speeds obtained with the BB 0401 locomotive and in comparison the same relative curves with the BB locomotives of the 0325 and 241 series.

The use of compensation on the MIT motors has permitted the reduction of

that its maximum speed in service is 115 against 105 km. (65 miles) per hour for the preceding classes.

From the traffic point of view, hauling conditions at 1 350 volts, which are the most usual, are given in the following table.

Load in tonnes.	*Speed at 1 350 V. in km. (and m.p.h.) per hour.*				
	Gradients in mm. per m.				
	0	*2*	*2.8*	*5*	*8*
Goods : 1 300 *(1 279 Engl. t.)*	82.5 *(51.26)*	70 *(43.49)*	65 *(40.38)*	53.5 *(33.24)*	
Express freight : 680 *(679 Engl. t.)* .	110.5 *(68.66)*	101.5 *(63.06)*		84.5 *(52.5)*	70.5 *(43.80)*
Passenger : 500 *(492 Engl. t.)* . . .	115 *(71)*	113.5 *(70.52)*		101.5 *(63.06)*	86.5 *(53.74)*
650 *(639 Engl. t.)* . . .	115 *(71)*	104 *(64.62)*		87.5 *(54.36)*	72.5 *(45.04)*

These working conditions are kept within the continuous rating of the MIT motors, and with a single reduction gear, which lead to the following observations :

Goods. — With the previous locomotives, speeds of only 74, 59.5, 55 or 43.5 km. (46, 37, 34 or 27 miles) per hour, respectively for the same gradients with a goods train of 1 300 t. were obtained.

It can be seen that it is possible with a BB 0401 locomotive to either increase the speed of a train with a load of 1 300 t. or increase the load hauled at the same speed.

On the Paris-Lyons line, on which the load has to be limited, owing to the entry into Bourgogne (gradient of 8 mm. per m.), single heading will be possible with a BB 0401 locomotive for all trains of not more than 1 050 t. (1 033 Engl. t.). This limit would have been 900 t. with a Bo Bo 0325 locomotive.

Express freight. — It is interesting to note that as against a speed of 82.5 km per hour on a gradient of 2 mm. per m. with the old BB locomotives, a BB 0401, working under the same conditions, would have a speed of approximately 100 km. (62 miles) per hour which would give an average timing of 80 km. (49.7 miles) per hour in service. For this type of traffic, it will, therefore, be possible to use a BB 0401 when, previously, it was necessary to use a 2 Do 2 locomotive in order that the schedule could be kept.

Passenger. — Figure 3 shows that the BB 0401 gives very much higher tractive force at the wheel rim to those of the preceding BB type locomotives at high speeds. At 105 km. (65 miles) per hour, these forces are increased from 2 800 kgr. (6 172 lbs.) to 5 500 kgr. (12 125 lbs.). The performances of these locomotives are, therefore, considerably improved. Thus, a train of 500 t. (492 Engl. t.) which, previously, was scheduled to work at 85 km. (52 miles) per hour, could work at 105 km. per hour with the BB 0401. Under the same conditions, a train of 650 t. (639 Engl. t) could be scheduled at 100 km. per hour and a train of 750 t. (738 Engl. t.) at 95 km. (59 miles) per hour approximately.

BB 0401 type locomotives can haul most passenger trains other than express or semi-fast, which must work at 120-140 km. (74-87 miles) per hour.

Comparison will now be made with the *Mikado* type 2-8-2 P locomotive, a type

of locomotive which is considered to give the best results. Figure 4 shows the 2-8-2 P locomotive which is slightly superior to the present BB type, but slightly inferior to the BB 0401. Therefore, every train hauled by a 2-8-2 P locomotive into an electrified station could be hauled by a BB 0401 locomotive, at equally good speeds, or perhaps even better.

ferent steps. The ratio of the current change which was 1.21 is thus reduced on BB 0401 to 1.14 with 40 steps.

— Increasing the number of shunting steps so as to obtain variations in forces when passing from one step to another similar in size as when starting on resistance. To fulfil these conditions, BB 0401 carries nine shunting steps equalised at each connection.

Owing to this fact, and also that

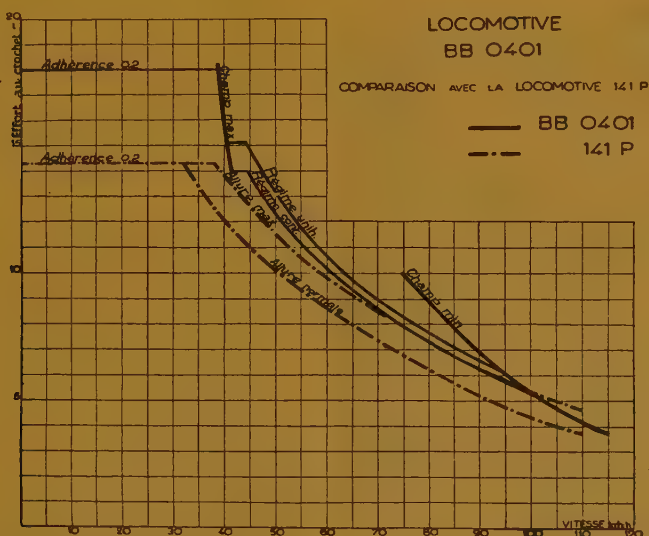


Fig. 4. — Comparison of electric locomotive BB 0401 and steam locomotive « Mikado » 2-8-2 P.

c) EASE OF DRIVING. — Without going into details of the electrical equipment, it should be pointed out that the improved characteristics mentioned above have been attained by re-designed apparatus with a view to improving acceleration :

— Adoption of bridge transition which reduces to a negligible degree the variations of current when connections are changed.

— Increasing appreciably the number of steps on resistances so as to obtain the least variation of current when passing the dif-

BB 0401 has only two couplings, the number of running steps is 20 in place of 12 as on the previous BB type.

The different locomotives have been compared, supposing them to have the same adhesive weight of 80 t. (73.73 Engl. t.).

In fact, the BB 0401 normally have an adhesive weight of 92 t. (80.70 Engl. t.) which takes full advantage of the load of 23 t. per axle allowed on the main lines of the S.N.C.F.

Almost the whole of the lines already

electrified and those to be electrified of the S.N.C.F. will permit an axle load of 23 t., but it will be some years before the whole programme is carried out. During this period, it is necessary to use one type of locomotive and to obtain a load of either 23 t. or 20 t. (19.684 Engl. t.) per axle by the simple addition or removal of ballast. In the first case, the increasing of adhesive

Fig. 5. — Driving cab.

weight by 15 % improves adhesion factor of the locomotive, especially for starting up on gradients with heavy trains.

d) COMFORT OF THE CREW. — By eliminating the circulating doors, the cab could be generally arranged identically with those of high speed locomotives (fig. 5). Two large front windows improve visibility and the adoption of double walls and double roofs make the cabs much more comfortable both in Winter and Summer.

On the BB 0401 locomotive, the heating of the cabs is by ærotherm, which ensures a circulation of hot air, some of which passes between the double front windows and acts at the same time as a window wiper.

In addition, a 1 000 watts heater is installed in the cab so that the crew can heat their food en route.

The length of the electrified lines will more and more require the fitting of this equipment so that long journeys can be undertaken without discomfort or fatigue to the crew.

III. Particulars of construction.

Nearly 600 BB type locomotives are actually in service on the various electrified lines of the S.N.C.F. They are divided into 13 classes, practically all designed by ALSTHOM to carry out very different programmes. It is sometimes laid down that electric braking must be added.

Improvements have been made as each class was designed, particularly to increase the power, which rose from 1 000 to 1 600 and then to 2 000 H.P., to reduce wear in service and to increase robustness and safety.

Through this it was possible to increase the mileage between general repairs to more than 140 000 km. (87 000 miles) and at each repair to lessen the number of details which had to be inspected or replaced owing to wear.

These results could only be obtained by close and constant collaboration between the technical staff of the S.N.C.F. and the builder.

When the BB 0401 locomotive was being designed, the S.N.C.F. drew particular attention to the necessity for

increased ease of stripping and accessibility at Works and Depots. The aim was for a further reduction of time out of traffic during general repairs or periodical examinations.

The design of the various details was studied with this object in view and it should be noted that it was greatly facilitated by the fact that all the general arrangement drawings, mechanical details and electrical equipment had been designed in one drawing office, and the manufacture of the material also was carried out in one workshop.

The particular constructional details in which the BB 0401 locomotive differs from the preceding series are as follows :

a) MECHANICAL. — *Bogie frame.* — To increase the robustness of the solebars, tubular frames were adopted made of two sheets pressed in [] and electrically welded (fig. 6). It was possible to decrease the moment of inertia for less weight. Such an increase in the transverse rigidity of the underframe improves the resistance of the underframe to buffing shocks and must also improve the stability of the locomotive.

Fig. 6. — Bogie frame.

Suppression of Guides. — All railway vehicles are normally fitted with axleboxes working on guides. This arrangement gives trouble owing to wear, the rubbing parts not being able to be protected against sand or dust, nor conveniently lubricated.

The axleboxes of the BB 0401 locomotive had no guides, but are attached to the frame by links mounted on silentblocs as shown in figure 7.

When there is a vertical displacement, the links incline themselves, the silentblocs are deformed by torsion and in order to compensate the lessening of the horizontal length of the links, the box is slightly rotated without any difficulty.

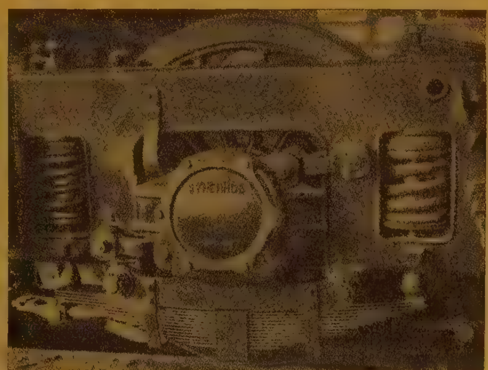


Fig. 7. — Main suspension and axlebox.

Under the action of the lateral forces, transmitted to the box, the silentblocs undergo a conical crushing, which acts as a recoil force attaining 10-11 t. (9.84-10.82 Engl. t.) per axle for a lateral displacement of 5 mm. (13/64″) maximum.

In addition to eliminating oiling, the arrangement adopted enables shocks between the box and underframe to be prevented and keeps the locomotive indefinitely « in new condition ».

Braking. — Each wheel is braked by two brake shoes. The two wheels at

each side of the same bogie are braked by rigging governed by a cylinder which has a regulator of the SAB type.

It has been arranged that the brake shoes can be completely worn out before the brake rigging has to be touched.

The use of regulators and the considerable increase in the rubbing surfaces of the shoes must bring about an important reduction in maintenance costs.

The armature is mounted on roller bearings which have grease lubrication.

In order to improve the condition in service of the axle bearings, mechanical lubrication, obtained by the circulation of oil with a geared pump governed by teeth mounted on the axle has been provided. Arrangements have been made for the retention of oil at each end of the bearings.

In order to mitigate against lateral shocks to the motors when entering or leaving curves, the body has been joined transversely to the bogie underframe by a link mounted on silentblocs (fig. 8), and the axle bearings have a side play of 2 × 10 mm. (5/64″ × 25/64″). Particular care was given to the design of the gears, bearing in mind the increase of power and the teeth were case hardened, heat treated and normalised both for the spur and the pinions.

Fig. 8. — Connection between motor and bogie frame.

Articulation. — The whole of the articulation of the brake rigging and suspension for locomotives of this class have been fitted with rings and pins in manganese steel.

Speed indicator apparatus. — With the same object, all the shafts of the gear boxes of the locomotives of this series have been mounted on roller bearings.

b) ELECTRICAL. — *Traction motors.* — Investigation into the design of the MIT motors was carried out, not only to increase the performance of the locomotive, but also to reduce wear and risk of accidents.

Special arrangements were made in order to facilitate access to the brush holders. They are mounted on a turning crown which enables them to be brought successively to the inspection holes.

The motor is compensated and at half tension, the average and maximum tensions are, in all circumstances, less than those of the standard 1 500 volt. motors with the results that they give very good service (fig. 9).

Apparatus. — In order to reduce time out of service, all apparatus (individual switches or cam switches, resistances, etc.) have been grouped in accordance with their functions in blocks which are interchangeable, comprising a fixing board, cabling and compressed air pipes.

The blocks can be very rapidly disconnected and withdrawn through the roof of the locomotive (fig. 10), the whole of which between the two cabins opens. In service, this opening is closed by three moveable hoods. The end hoods each have a pantograph as well as ventilator.

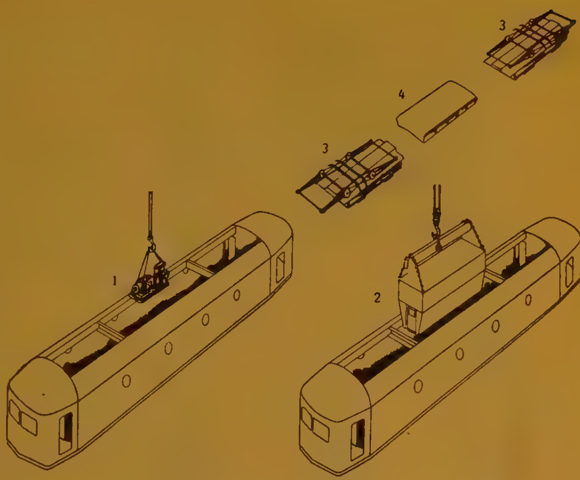


Fig. 10. — Taking down the blocks of apparatus.

Fig. 9. — Body of MIT motor.

Owing to this fact, it is possible to take out any block very quickly and replace it by an exchange block.

For inspection at depots, each block is so made as to facilitate access to the apparatus. In addition, each apparatus can be separately demounted from its block, particularly the individual contactor switches which have been mounted on insulated supports (fig. 11), which fix the apparatus and also its high tension electric connections. The low tension connections between the blocks and the cabling have been carried out by couplers as multiple plugs.

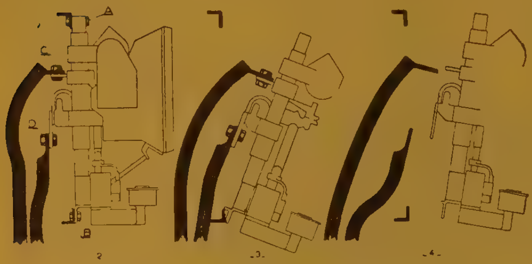
The groups of apparatus in the driving cab and the pneumatic apparatus have been arranged in a similar manner.

It is thought that these arrangements are very helpful during general repairs. The staff, instead of having to work inside the body under difficult conditions, owing to the small space at their disposal, can work to a large extent on the outside. Working conditions are, therefore, better and a reduction in shopping time will result.

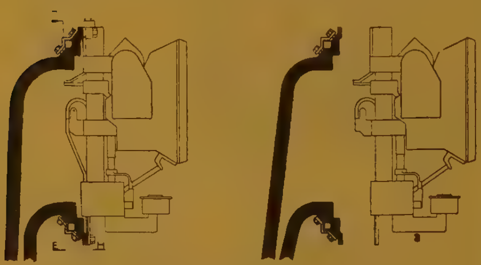
Ventilation and protection against dust. — Experience shows that one of the most important operations in the maintenance of electric current is dedusting, which is necessary in order to maintain the insulating surface and low tension contacts in proper condition.

Dust comes from ballast, from wear of brake shoes, and from steam locomotives' smoke.

It enters by the ventilating openings of the traction motors which consume approximately 6 cu. m. (212 cu. ft.) of air per second in a BB locomotive. On the BB 0401 locomotive, special



OLD METHOD.
The taking down of contactor from the front, requiring 4 operations (1, 2, 3, 4).



NEW METHOD.
(Insulated supports E.)
To take down the contactor screw.
H only has to be removed.

Fig. 11. — Fixing of contactors.

arrangements have been adopted by eliminating the ventilators on the sides, and taking all necessary air through the roof, that is to say, where there is a minimum of dust.

In addition, the ventilating air for the motors is taken there direct by tubes which are very easy to take down and it no longer circulates round the apparatus.

An auxiliary ventilator is mounted on each motor ventilator group to ensure that the apparatus has some ventilation including resistances and prevents the entrance of snow and dust in the body.

In the examples chosen, it has been shown that the adoption of new ideas in the general design of the locomotive has been accompanied by research to improve details so that the whole arrangement is homogeneous and robust.

IV. Arrangements adopted so that it can be manufactured in series.

After examining the different solutions, it was recognised that to manufacture in series it would be a good idea to adopt an entirely welded construction for the mechanical portions, both for the body, which can form a tube, as in our newest construction [1] and also for the bogies.

The possibilities offered by electric welding are such that one obtains, for the least weight, the greatest robustness and partial assemblies can be undertaken with single details as well as with large sheets. Finally, after many separate and well defined operations to the mechanical portions and the mounting of the equipment, the locomotive is ready for service.

So that such manufacture shall be really economical, it is essential that the workshops should be arranged for the different operations envisaged; and, bearing in mind the jigs and tools necessary, a large series of locomotives should be constructed without modifications.

Figure 12 shows the building shops at Belfort arranged for building the mechanical portions of the BB 0401 type locomotive in series.

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(1) See *Revue Générale des Chemins de fer*, July-August, 1944, N°. Article by M. DENAVARRE on a new method for calculating the bodies of locomotives, also applicable to carriage, railcar and van bodies.

These workshops consist of one large building 250 m. (820 ft.) long. This permits the building of locomotives to proceed not on the assembly line principle, but so that there is not a continuous movement of locomotives in course of production, but the successive fitting together of different parts of equal duration. This large building is fed by adjacent specialising shops.

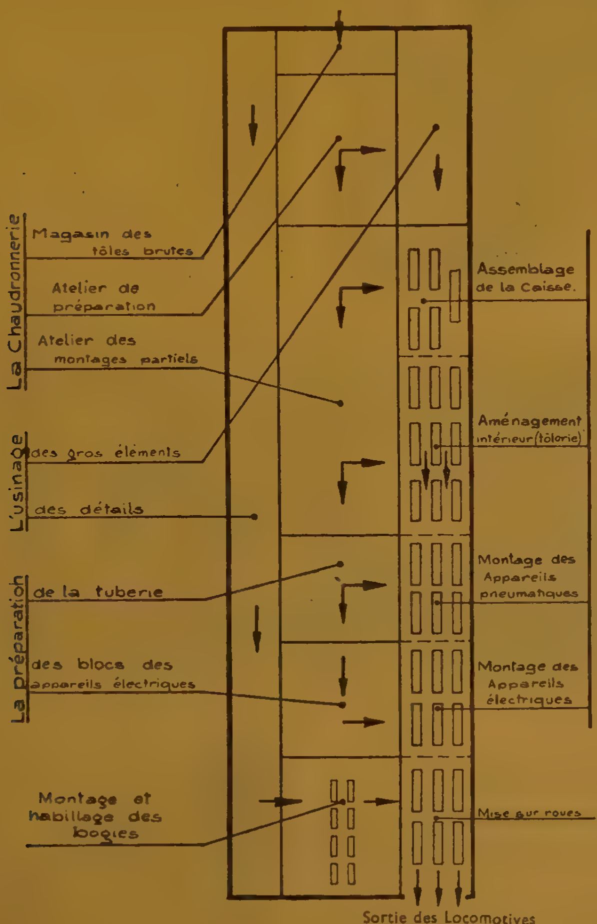

Fig. 12. — Diagram of Works.

Explanation of French terms:

La chaudronnerie = boiler making. — Magasin des tôles brutes = raw material store. — Atelier de preparation = workshop for preparing material. — Atelier des montages partiels = workshop for partial mounting. — L'usinage = workshop. — des gros elements = large parts. — des détails = details. — La préparation = preparation. — de la tuberie = pipe work. — des blocs des appareils électriques = blocks for the electrical apparatus. — Montage et habillage des bogies = mounting and fitting of bogies. — Habillage de la caisse = body work. — Assemblage de la caisse = assembly of the body. — Amenagement intérieur (tolerie) = arrangement of the interior. — Montage des appareils pneumatiques = fitting of the pneumatic apparatus. — Montage des appareils électriques = fitting of the electrical apparatus. — Mise sur roues = fitting of wheels. — Sortie des locomotives = locomotives out of shops.

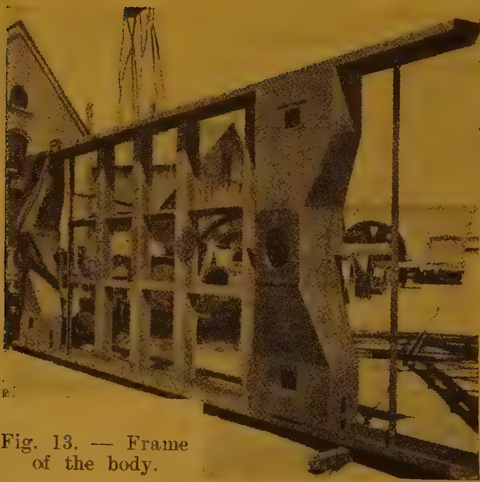

Fig. 13. — Frame of the body.

The first operations are the assembling of the side sheets and the cross partitions which form the staying. They are followed by the mounting of the two end cabs.

A body thus built up is then fitted on the underframe which enables it to be moved without using rollers. It then receives successively its interior fittings, desks, double partitions, doors, etc. It is then passed along for the mounting of pipes where the brake equipment is fitted.

The next operation is cabling where (after the cables are mounted in the cable conduits) the apparatus blocks, first cabled and verified, are lowered into the body to be connected together.

Fig. 14. — Mounting the side sheet on the central frame.

Then the moveable hoods are placed in position on the roof.

The last stage of manufacture consists of mounting the body on its bogies, which latter have been mounted in the specialising workshops, following the same principle.

The photographs taken during the assembly of locomotive BB 0401 show the different stages, which have been mentioned better than a description (fig. 13-15).

To summarise, the BB 0401 locomotive shows a very marked advance both in its field of operation as well as for construction. This progress increases the interest which the development of electric traction presents for France.

Fig. 15. — Mounting and fitting the central block.

NEW BOOKS AND PUBLICATIONS.

[347 .762 (43)]

SANTONI (Giuseppe). — **Il contratto per il Trasporto delle cose sulle Ferrovie dello Stato. Commento alle vigente « Condizioni ».** *(Goods transport contracts on the Italian State Railways. A commentary on the conditions in force).* — One volume ($6\frac{1}{2} \times 9\frac{1}{2}$ inches) of 262 pages. — 1947, published by Scienta, Coop., Roma.

There is no need to insist upon the importance of the transport contract nor on its special nature in a publication like this *Bulletin*. Its extent and its character of a public service sufficiently explain why railway transport must be under uniform regulations. In addition, however, in most countries there is special legislation with a special code applying to it and even distinguishing it from other methods of transport.

A knowledge of this special legislation, at least in so far as its essential principles and the regulations authorised thereby are concerned, is needed by railway employees who have to take part in commercial operations and in litigation.

Actually speaking the numerous and diverse clauses, which as a whole make up the transport contract, are summed up in the administrative instructions and generally accompanied by the explanations needed to apply them. In addition, however, as they are often scattered, it is not possible to make a lengthy commentary on them in service documents.

The merit of a book such as Mr. SANTONI's is that it gives a methodical and complete analysis of all the legislative and administrative clauses applicable in the matter. In his very thorough study, the author deals with the object of the regulations in force, their origins, and their field of application, how they are intended to protect the interests of the public or avoid undue responsibility on the part of the transporter, and how they are sometimes the fruit of compromise between opposing tendencies. Without burdening his report by quoting the actual texts in full, for which the reader is referred to the official clauses of the regulations, he defines very clearly the rights as well as the obligations of each party.

The book is composed of six main divisions : introduction, general regulations contained in the « conditions and rates », the transport of luggage, express and slow goods, the responsibility of the railway, claims and lawsuits. The subject is sufficiently indicated by the titles, at least in the case of the five last. In his introduction, the author examines the legal foundations of the transport contract, the characteristics of railway legislation, the different interpretations that can be put upon the law, and finally the regulations concerning changes in the conditions and rates.

Two categories of readers will be interested in this book. Besides railway employees who will consult it in order to strengthen and extend their professional knowledge, all consignors and their counsels will find it a precious guide giving them authoritative information on the best way in which to fulfil their obligations and if need be to affirm their rights. It is also an invaluable source of information for those who wish to make comparative studies of railway legislation.

E. M.

[385. (09 (.45)]

La Ricostruzione delle Ferrovie Italiane dello Stato. *(The reconstruction of the Italian State Railways).* — One brochure ($6\frac{1}{2} \times 9\frac{1}{2}$ inches) of 16 pages, copiously illustrated, with a summary in French. — Published by « *Ingegneria Ferroviaria* », Rivista dei Trasporti, Piazzale delle Scienze, 7, Roma, with the approval of the Italian State Railways.

In Italy, as in the other countries grievously tried by the war, the lack of means of communication has hampered the recovery of the economic life of the country. Amongst these the railway which is the most powerful and most necessary of the lot had suffered considerable damage. The author of this pamphlet wished to show the extent of the task to be accomplished, the methods employed, and the results already obtained.

The tale of the damage is impressive : 4 500 km. (2 796 miles) of permanent way (21 % of the system), 2 600 km. (1 615 miles) of station sidings (35 %), 68 km. (42 miles) of masonry bridges (28 %), 35 km. (21 miles) of metal bridges (45 %), 64 km. (39 miles) of tunnels (7 %), 10 000 buildings of various kinds (65 %), 3 850 km. (2 392 miles) of high-tension electric lines (65 %), 8 200 km. (4 473 miles) of contact lines (69 %) and about 40 % of the signal installation. As regards rolling stock, the losses due to destruction, serious damage or pillage were equally important : 2 300 steam locomotives (59 %), 1 000 electric locomotives (78 %), 170 railcars and electric trains (80 %), 770 steam railcars (96 %), 9 900 passenger coaches, vans and mailvans (81 %), and approximately 100 000 goods waggons (73 %).

To the considerable material difficulties due to the shortage of materials must be added the position of the staff, which had been grievously affected by the war and whose working conditions were extremely difficult. The author pays tribute to the behaviour of the staff during the occupation of the country and to their devotion and courage in carrying out their duties during the reconstruction of the railway. As for private industry, here again raw materials such as coal and electricity were lacking. Supplies from abroad could not be counted on owing to the famine from which the whole world was suffering as well as the lack of shipping space.

Amongst the general measures prescribed in the reconstruction of installations, the author mentions the following: restore the main lines first of all as quickly as possible, make use of as much labour and as little material as possible, especially material coming from abroad, and make the fullest possible use of all salvage.

At the time of publication (May 1947), 50 % of the damaged lines have been restored, 42 % of the masonry bridges, 20 % of the metal bridges, 33 % of the tunnels, 54 % of the buildings, 48 % of the high-tension lines, 54 % of the contact lines, and 20 % of the signalling equipment. As regards rolling stock, the stock has been considerably increased in the course of the year both by new constructions and by repairs. This was followed by a rapid increase in the traffic and an increase in the receipts which made it possible for the Railway Administration to pay its way without aid from the Treasury. The author gives some figures, which show the progress made in passenger train services on the main lines.

He then gives a brief review of the work that remains to be done to restore the fixed equipment to a satisfactory state of repair. The figures given for rolling stock show that the situation will be much more favourable at the end of 1950 than it was in 1940.

The total cost of reconstruction has

been estimated at 400 thousand million lira.

Many technical innovations will be introduced during the reconstruction made necessary on account of war damage. In the case of fixed equipment, mention may be made of the realignment of the permanent way, new types of track equipment, better bridges, a new method of light signals with four positions, the extension of the automatic block, cab signals, electric signal boxes in the main line stations which automatically work the points and signals by route levers, automatic telephone communications throughout the system, and teleprinter equipment. The electrification programme has been extended and now covers a number of additional lines.

As regards rolling stock, the weight of passenger coaches will be reduced and they will be better designed from various aspects; eight new electric trains on order will be equipped with many improvements. Mention must also be made of radio communication between the passenger trains and the stations, so that passengers can send telegrams; the adoption of the continuous brake on goods trains, and the lightening of axles and axle-boxes.

Some of the illustrations to this little pamphlet show the extent and gravity of certain damage, whilst others show new achievements, remarkable structures, modern stations, and recent types of rolling stock.

E. M.

[**621** .33 (.44)]

DUGAS (René). — Chief of the Technical Department of the French National Railways. — **L'électrification des chemins de fer français** *(The electrification of the French Railways).* — A report presented to the « Société d'Encouragement pour l'Industrie Nationale » (Paris). Reprinted from the Review :« *Reconstruction* ».

This note gives us a succinct and valuable report on the present position of electrification in France.

A brief historical review brings us to the year 1926 when the first main artery was equipped for purely economic reasons, namely the Paris-Orleans-Vierzon line where the density of consumption reached 1 100 tons of coal between Paris and Orleans. According to the Government decision of 1920, the railways had to adopt such a system of electrification that the feeding of the traction substations would be assured by three phase 50 cycle current. Besides the construction of dams, high tension lines were erected to get even distribution of the power generated at the hydraulic works, as well as between these works and the central power plants. Just before the war, including the Brive-Montauban line completed in 1943, the electrified system was equipped with substations giving a power of 600 000 kW.-h. The net saving in coal was equal to 1 200 000 tons a year, corresponding to a consumption of 370 tons per kilometre per year.

The author gives a brief outline of the programme recently announced as the result of studies carried out since 1938. A map is given showing the lines already completed, those under construction, and the proposed new lines. These include in particular the main line between Paris and Marseilles, with the Lyons-Geneva and Macon-Culoz lines, the Bordeaux-Montauban and Sete-Nimes lines, the Ceinture south of Paris, the suburban lines north of Paris, and additions to the Ceinture on the west. The whole programme to be completed in the next years covers 2 074 km. (1 217 miles) of line. The average consumption of coal is 700 tons. When these lines have been completed, the French electrified system will be 5 600 km. (3 479 miles) long,

with an annual consumption of 1 900 million kW.-h., corresponding to a saving of 2 600 000 tons of coal. Another more detailed map shows the Parisian suburban lines.

Very interesting information is given on the characteristics of the lines, the nature of the traffic to be worked, the loads and speeds of the trains, the new operating methods (automatic block with light signals and centralised control making possible the localisation of lines over long distances).

As regards the choice of current for traction the author explains the circumstances and considerations which have led the French engineers to retain 1 500 volt direct current, whilst keeping an open mind as regards the future possibilities of single phase 50 cycle current.

The studies made and the experience acquired have enabled the types of rolling stock to be determined. The author gives the leading characteristics of passenger locomotives, goods locomotives, shunting locomotives, railcars and train units (railcars and trailers).

In the case of passenger traffic, the new 2D2, weighing 150 metric tons, with an adhesive weight of 92 metric tons, and a continuous power rating of 5 000 H.P., maximum speed 160 km. (99 miles)/h., can haul 850 metric tons at 140 km. (87 miles)/h. on the level and climb the Bourgogne heights (gradient 8 $^0/_{00}$) at 100 km. (62 miles)/h.

In the case of goods traffic, the type BB, weight 92 metric tons, power 2 600 H.P., maximum speed 105 km. (65 miles)/h., can haul 680 metric ton mail trains at 105 km./h. on the level and 1 300 metric ton goods trains at 85 km. (52 miles)/h. For difficult sections of line (gradients of more than 10 $^0/_{00}$), two prototypes are under construction, the type BBB and the type CC.

The programme described above has already been partially carried out. It is not the result of circumstances but the fruit of long and patient study, though its usefulness has been enhanced by the general shortage of coal in Europe.

E. M.

[**656** .222 .5]

GUTERSOHN (Alfred). — **Der Eisenbahnfahrplan für den Personenverkehr.** *(Railway timetables for the passenger services).* Thesis presented by the author for the degree of Doctor of Political Science of the Faculty of Law at the University of Berne. — One volume (6 × 9 inches) of 214 pages. — 1940, Soleure, Imprimerie Vogt-Schild, A. G.

The issue of a new timetable is always quite an event for the public. All those who make frequent use of the railway, such as business-men, commercial travellers, workmen, and clerical staff want to know if it will be as easy for them to get to their place of work or perhaps further facilities will be offered them. And a great many other people as well are very interested in the train services. But though the traveller looks upon the timetables as a summary of the services offered by the railway, very few people appreciate the fact that they are the result of long months of work during which the railway considered all the demands of its clientele and the technical resources available.

The question of the timetables has many other aspects as well and it has a very close connection with the general economy of a country. It is therefore understandable that the author has chosen this subject as the thesis for a Doctors' degree. The study he has made of the subject is remarkably well conceived and documentated.

In the first part which we consider

to be the most substantial and which moreover takes up half the work, Mr. GUTERSOHN develops what he calls the material aspect of the problem of the timetables. This contains a very through analysis of the different interests which the train services must satisfy and the multiple activities which are affected for better or worse according to the way the services are planned. This is only one example selected from amongst many to show the care with which the author has methodically explored the subject.

The second part is devoted to what may be called the administrative side of the timetables : negociations and discussions with the authorities and others concerned, legal basis of the timetables, frequency of services, structure of the advertising, service and investigation documents.

Important as the timetables are to the public, they are just as much so to the railway. They can be a powerful factor in attracting traffic. Moreover there is a very close connection between them and the rating policy. These considerations are developed in the third part of the thesis. The reader will certainly appreciate the chapter devoted to the part played by the timetables in the fight against motor and air competition.

In the fourth part, the author makes a very interesting comparison between the leading characteristics of the train services in various European countries.

Finally in the fifth part, he expresses as the result of his investigations certain ideas of his own upon the future development of the work of preparing the timetables in Switzerland. He insists upon the usefulness of multiplying the contacts between the railway authorities and all those concerned so that the services needed and their nature can be appreciated. In many directions, there is question not only of speeding up but also increasing the services, that is to say the number of trains. What the public wants is the introduction of through services, and when there are no through services, improved connections. If the time lost in the stations is diminished, in a country like Switzerland this will make good the effect of the relatively low speeds sometimes imposed by the profil of the lines.

E. M.

[**313** .385 (.494)]

Schweizerische Eisenbahnstatistik. *(Swiss Railway Statistics)* - 1946. — One volume ($8\frac{1}{4} \times 11\frac{1}{2}$ inches) of 208 pages with tables included. — 1947, Berne, published by the Federal Transport Office. (Price : 5 Swiss francs.)

This book is the 74th statistical publication issued by the Swiss railways. It contains very detailed information on the position and working of railway transport undertakings. It covers the standard gauge and narrow gauge lines, tramways and funicular railways.

The first series of graphs gives the extent of the lines of each undertaking together with the number of lines and method of traction. At the end of 1946 a total of 5 793 km. (3 600 miles) was in operation, 3 643 km. (2 264 miles) being standard gauge, 1 579 km. (982 miles) narrow gauge, 104 km. (64 miles) rack railway, 406 km. (252 miles) tramways, and 61 km. (38 miles) funicular railways. These figures include the lines operated by the Swiss Federal Railways, which consist of 2 884 km. (1 792 miles) of standard gauge and 73 km. (45 miles) of narrow gauge (the Brunig line). Amongst the standard gauge lines, 31.7 % are double track lines. Electric traction is used over 88.4 % of standard gauge lines and 96.2 % of the narrow gauge lines.

Another series of tables grouped un-

der the heading : « *Lengths and technical installations* » give the tunnels and bridges, length of sections of line on the straight and on curves of different radii, on the level and on various gradients, the types of rails and sleepers used, the track equipment in the stations, the signalling methods and operating methods. On the Swiss Federal Railways the average distance between stations is 3 620 m. (3 960 yards).

The station situated at the highest altitude on the standard gauge lines is on the Berne-Lotschberg-Simplon line (1 216 m. = 3 988 ft.), the record for narrow gauge lines is held by the Rhaetian Railway (2 253 m. = 7 390 ft.), and that for the rack railways by the Jungfrau (3 454 m. = 11 331 ft.).

The following tables give full details about the rolling stock followed by statistics for the mileage covered by the different categories of stock.

An analysis of the traffic is given in such a way as to bring out the most interesting features. In this way the evolution of the traffic during the course of several years can be followed. In 1946 the average mileage travelled per passenger was 26.4 km. (16.4 miles) on the Swiss Federal Railways, and the average journey per ton of goods 100.8 km. (62 miles).

We then come to the commercial and financial field. First of all there are details concerning the first costs. The sum total is 3 436 millions. The figures given make it possible to compare the costs of the fixed equipment, buildings, and rolling stock in terms of absolute value and in comparison with the mileage.

The operating results are given in tables giving an analysis of the receipts, the expenses, the profit and loss account, the product and changes in the capital invested, and the balance sheets. The operating coefficient varies considerably from one undertaking to another. In the case of the Swiss Federal Railways it was equal to 69.3, 71.4 and 66.1 respectively for the years 1930, 1945 and 1946. On all the railways properly so called there was a new increase in the receipts in 1946, due above all to the goods traffic. In the case of the tramways, the receipts which have shown large increases were stabilised in 1946.

Statistics of accidents, and figures relating to the staff and staff funds complete the information given. For the standard gauge, narrow gauge and rack railways there has been no great variation in the total staff when the years 1910, 1930, 1945 and 1946 are compared. On the Swiss Federal Railways the average staff for the year 1946 is equal to 11.65 per km. of line in operation.

These well conceived and well presented statistics make it possible to get a very clear idea of the material situation of the railways in Switzerland and to appreciate the results obtained by the operation. It can be said that the position is satisfactory, and even prosperous.

E. M.

[621 .33 (.493)]

Electrification of 1 500 km. (932 miles) of railway lines. Report presented by the National Electrification Commission of the Belgian Railways - 1947. One brochure ($8\frac{1}{4} \times 11\frac{3}{4}$ in.) of 92 pages, copiously illustrated, several maps. — 1947, published by the above-mentioned Commission and printed by the Belgian National Railways, 21, rue de Louvain, Brussels.

The Commission, which prepared this report, was set up on the 26th April 1945 by M. RONGVAUX, who was Minister of Communications at that time. In his preliminary discourse, which is given at the beginning of the report, he reported the reasons which led to the creation of this commission.

It will be remembered that the Belgian National Railways completed in 1925 the electrification of the 44 km. (27 miles) long line between the capital of the country and the port of Antwerp. As a result of the good results obtained by this first application and as a conclusion of the research made in order to extend the benefit of this new method of traction to other lines, agreements were concluded between the State and the Belgian National Railways covering a programme known as the « Petite Etoile ». This included the main lines radiating from Brussels for some 30 km. (18 miles) in addition to the whole line between Brussels and Charleroi, 56 km. (34 miles) long, i.e. 175 km. (108 miles) in all.

The war prevented the carrying out of this project and the destruction caused by it has modified the whole question. In particular there is a great shortage of rolling stock. Ideas have also changed and the demand for better communication between Brussels and the outer suburbs has become more pressing. These considerations and other circumstances analysed in the report show that the whole problem had to be re-examined. The Commission have considered it from every aspect : economic, technical, financial, social.

In the light of the information collected by its various members, the Commission is of the opinion that within a short time some 1 500 km. of lines would be electrified, including the Brussels-Charleroi line, work on which has already commenced. A map gives the lines concerned, with the approximate dates. They are all lines ending at Brussels, except the Brussels-Tournai line, with various branches such as Athus-Meuse, which doubles the main Luxembourg line, the Marloie to Liege line, the important cross country line from Tournai to Liege, and the Ghent-Charleroi line. Nearly all the large towns are affected. The industrial centres of Liege, Charleroi and Mons are connected together as well as to the ports of Antwerp and Ghent. Whereas at the present time only the passenger services on the Brussels-Antwerp line are electrified, all the trains will be electrified now. As the system covers 1 991 km. (1 237 miles) of single track and 3 000 km. (1 864 miles) of double track lines, about half the system will be electrified; the traffic on these lines in 1938 represented 70 % of the total traffic.

The execution of this programme is divided into 15 stages. The final stages will be completed by 1951, which presupposes the electrification of 300 km. (186 miles) a year. As its first criterion the Commission had to consider the annual consumption in kW.-h. per km., but other considerations also guided it in its choice of lines. The carrying out of certain stages depends upon civil engineering works, the modification of stations, and quadrupling of lines.

Before giving details of the programme, the report analyses the reasons requiring a profound and rapid transformation of the Belgian system of operation. To reasons of a railway character based on special circumstances proper to the Belgian system and the present position as regards fixed equipment and rolling stock, must be added reasons of a general nature. Amongst the latter are the interests of the public, that of the heritage of the railway, and that of the staff. The industry of the country, which will be called upon in designing and supplying equipment, will in addition reap the benefits of invaluable experience and publicity.

As regards the choice of the method of traction, taking into account the present state of technical knowledge and the information to be obtained from applications realised in other countries, the Commission has decided in favour of direct current at 3 000 volts, a solution which harmonises with that already adopted on the Brussels-Antwerp line.

To obtain the necessary power, the Commission is of the opinion that the railway should have recourse to the existing producers of electricity, the latter having to make the necessary extensions, with the reservation that the price to the Belgian National Railways is satisfactory.

An important part of the report deals with the carrying out of the work. Whilst examining the different categories of work to be undertaken, the authors discuss their influence on the general economy of the country and the motives which justify speeding up their execution. The Commission indicates the expense that will be involved in the case of each line, the total amounting to 13.5 thousand million, and the way this is to be financed. From this total must be deducted the cost of obtaining new rolling stock. The report insists upon the priority to be given to the Belgian National Railways for the loans to be made and expresses the wish that a policy of co-ordination of transport will be actively pursued in order to enable the railway to retain its share of the traffic.

In reviewing new inventions likely to be of the interest to the railway, the Commission concludes that these are of such a nature as to make electric traction still more attractive.

E. M.

[656 .1 (.67)]

Union of South Africa. - Report of the Commission of inquiry into road motor transportation (1945). — One volume ($8\frac{1}{2} \times 12\frac{1}{2}$ in.) of 184 pages and a map. — 1947, Pretoria Government Printer of the Union of South Africa. (Price : 7 s. 6 d.)

The Commission presenting this report was set up in October 1945 by the Government of the Union of South Africa to study the conditions under which motor road transportation was working in the Union and in the Mandated Territory of South-West Africa. Certain aspects of the problem specified in the act of constitution were to be specially investigated.

According to the terms of its mission the Commission did not consider it should limit its investigations to commercial transport undertakings and public services but also extend them to cover private vehicles used by their owners for their own business. Other questions were examined because they were linked up with the explicit task of the Commission. Amongst these the two most important are the effect on other transport services, especially the railway, of the increasing development of road motor transport, and the construction and maintenance of the roads.

The most important road motor transport service is that operated by the South African Railways and Harbours. The Commission considered whether they should be granted a monopoly of road transport and came to the conclusion that this was not advisable. Nor were they in favour of the idea of making a separate monopoly of road transport, in competition with the railway, but they recommended that the motor services operated by the S.A.R.H. should be given financial independence so that any deficit due to the favourable rates granted to their customers would not have to be supported by railway users.

This question of a monopoly was also examined as a whole together with other forms of concentration covered in the report by the term « nationalisation » and « socialisation », the exact meaning

of these terms being carefully explained. Having studied the opinions of many authors and specialists and other official connsellors, together with that of various groups, and after discussing the arguments put forward, the Commission did not recommend steps being taken to carry out the socialisation of transport in the Union according to a national plan. In their opinion the solution for the co-ordination of transport lies in maintaining effective commercial control by means of an official organisation based on the necessary organic powers. They report in full their conception of the constitution and functioning of the controlling organisation. The chapters of the report dealing with the general organisation and control of transport are the most interesting as these are the most disputed questions whose solution can have the greatest influence on the economic activity of the country. To be quite clear on the matter, the Commission also wished to know the existing regulations in many European and American countries, and they give a substantial analysis of these. The experience acquired in these countries supports the opinion of the Commission. As for the depositions collected during their enquiry, which are unanimous with two exceptions, the arguments of which are reported, these show that the commercial controls in force for some fifteen years should be maintained with a few amendments.

In one of the chapters mentioned above, entitled : General principles of commercial control, the Commission examines the legislation in force (Motor Carrier Transportation Act, 1930, and its amendments) the way it has been enforced, and makes various recommandations.

Private transport is also regulated. In the general interest as well as the interests of the carriers themselves, it is recommended that this control be maintained whilst making certain modifications.

Besides commercial control, which covers the use made of a vehicle, the report also covers control of the traffic where safety is the leading idea, and a whole series of measures are proposed to decrease the number of accidents.

From a somewhat different point of view, the Commission examines the working of urban passenger services, urban goods services, rural passenger and goods services, and suggests measures likely to increase their efficiency.

Throughout the report the Commission formulates opinions and recommendations. These are collected together in the last chapter; there are 167 all told and they fill 7 pages. This is the result of a very thorough enquiry and the fruit of a constructive work of criticism. It is proposed to set up a Co-ordination Committee and a Consulting Council, the usefulness of which has been described in a special chapter.

To conclude, without giving either a summary or an analysis of this report which is very extensive and fully documentated, we should like to mention once more the chapter dealing with highways and roads. This is a subject which the Commission considers to be an essential part of effective and sufficient transport. An examination of the development of the different highways and their condition has led the Commission to demand that much more be done than up to the present to rebuilt, repair and maintain the roads. Attention is called to those which have to be used in bringing the products of rural districts to the railway stations. Measures are proposed as regards the classification of roads, and the authorities entrusted with their upkeep and financial means. Effective remedies are suggested to do away with congestion on the main roads of the large towns.

E. M.

[656 .235]

SANTORO (Francesco). — **Struttura economica e technica delle tariffe ferroviarie** *(Economic and technical structure of railway rates).* VOLUME I *The general principles of goods tariffs and their application to the Italian rates.* — One volume (7×10 in.) of 444 pages. — VOLUME II : *Ordinary and special goods tariffs. Supplementary charges. The reform of the goods rates.* — One volume (7×10 in.) of 318 pages. — 1947, Milano, Dott A. Giuffre, editore.

This is a very important book to which the *Bulletin* is calling the attention of its readers. Owing to the extent of the field covered and the spirit in which it is conceived, it has the character of a veritable treatise. Of the two volumes already published, the first includes a study of the general principles, whilst the second considers goods rates. A third and last volume for which the author has already collected the necessary material will be devoted to passenger fares and mixed rates. Although the book is based when necessary upon information applicable to the Italian railways and tends towards finding solutions applicable to Italy, the ideas and theories developed are of general interest.

The *first volume* contains 25 chapters grouped in five main parts. Here are the subjects covered by each of these : I. — The value of goods. II. — Speed of transport. III. — The distance. IV. — The kind of transport. V. — Risks of irregularities in carrying out the transport.

The *second volume* consists of five parts containing 23 chapters, as under : I. — Principles of special tariffs. II. — Ordinary rates. III. — Special rates. IV. — Suplementary charges and the corresponding tariffs. V. — The structure of the goods rates and their approaching reform. An appendix constituting a 24th chapter contains a study of the relationship between the number of waggons and the rates, the effects and possibilities of an increase in the tonnage, and on the system of private waggons.

These summary indications will only give a very imperfect idea of the book, but it is impossible to give even a brief analysis of any one part of it. The subjects indicated in the headings are all investigated very thoroughly. To the interest felt in following the development of the theory is added the attraction of commentaries on phenonema actually observed by the author. He frequently has occasion to see in the evolution of the different rates the main phases through which Italy has passed since 1885. This is particularly so in the case of differential tariffs (on a diminishing basis) and the classification of the goods carried into slow and express goods. It is curious to see the repercussions on this classification of the measures necessitated by variations in weight of the national coinage.

As regards differential rates, the author reports the beginnings and advantages of the Belgian type of tariff. He discusses the numerous elements which come into play in fixing the rates in successive zones and the considerations which may limit them. Rather than the graphical representation showing the total rate he prefers that giving the kilometric base applied in each zone and an examination of the form of the curves for slow and express goods enables him to put forward some very suggestive considerations and reflections.

This book had been published at a time when a reform of the railway rates is being studied in Italy. A Commission was set up in November 1945 to examine this important problem. This gives the author an opportunity to discuss once

more the general structure of the rates, especially goods rates, above all taking into account the position in which the railway now finds itself, deprived of its monopoly and faced by road competition The fifth part of the second volume is devoted entirely to an examination of this question, and this is not the least interesting part of the book.

In the preface to the first volume, the author expresses the hope that this work will assist investigations into railway tariffs and will be useful to all those, whether railway men or others, who have to penetrate their secrets. It seems that this hope is likely to be fulfilled.

E. M.

[385. (09 (.44)]

DAUZET (Pierre), Inspecteur principal honoraire, French National Railways. — **Le siècle des Chemins de fer en France** (1821-1938) *(A Century of Railways in France - 1821-1938).* — One volume *8vo* of 320 pages with illustrations, engravings, maps, graphs and facsimiles. — On sale from the author M. Pierre Dauzet, 18bis, rue de Dunkerque, Paris (10^{e}). (Subscription price : 470 French francs.)

The design of the author of this work, which was published at the end of April 1948, was to integrate the work of the railway in the general history of France. Consequently, this is not a book for the erudite, nor a technical volume, but a book to be read by the common reader, synthetical and historical, which may become a classic in its own sphere. It is in fact the first time that a book of this sort has been written about the railways. A fragment relating to the birth of the Nord appeared in the review *Le Monde Français,* November 1946; another extract will be published shortly.

The matter is of topical interest. We have reached the centenaries of the main lines and the magnificent resistance of the railway to the enemy followed by its marvellous recovery has given a great aura to this great French undertaking. How could the ardent unions of railwaymen, throughout the country, how could the economists, the young students and all those interested in the lessons of the past, fail to be interested in learning more about the powerful organisation whose development since the revolution of 1830 has been closely bound up with the political, economical, financial and social life of the country ?

The author, the son of a stationmaster and the grandson of a tax collector, starting in a very humble way, has had a lengthy career on the Nord. Familiar with the study of history from his intimate collaboration with Gabriel HANOTAUX, he considered that in order to give a complete picture, he should bring to the light, side by side with the great achievements and future plans of the French National Railways, the brave initiatives, happy inventions, and profound opinions, not always unanimous, which have accompanied for more than 100 years the admirable evolution so wholeheartedly followed by four generations covering the hundred years of the railway.

We give below some of the chapters of the book :

A difficult birth (1821-1852). — The three ancestors of Saint-Etienne. — Saint-Simonisme and realisme. — The Saint-Germain line. — The Parliament and charter of 1842. — The Orleans, Rouen and Strasbourg lines. — The Belgian and English line.

The happy childhood (1852-1883). — The great amalgations. — The P.L.M. and Midi. — The 1859 Conventions. — The completion of the star of Legrand. —

Two generations. — Technique. — Great interests at war. — The world wide use of the French rail. — War without and competition within. — The State railway and the Freycinet plan. — The 1883 Conventions.

A happy quarter of a century (1883-1914). — Completion of the national system. — The time of harmony and green carpets. — Approaching the apogee. — From steam to electricity. — The altered face of France. — The efficiency of the lines in 1913. — The credit and social strength of the Companies.

War and its aftermath (1914-1930). — Under fire. — The 1921 Convention. — The reconstruction of the Nord and Est. — Soaring towards perfection. — Increasing traffic. — In the face of new demands.

The crisis (1930-1938). — Economic crisis. — Road competition. — Reform of the rates. — Heavy deficits one on top of the other. — The railway as pioneer in the Colonies. — The 1937 Convention. — The French National Railways. — The last hours of the peace. — The judgment of history.